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editor's letter

If we have conviction that buildings must be sustainable, and that we have workable methods to make this so, then we must pursue them with unbridled ambition. So it's thrilling to have helped Dún Laoghaire-Rathdown County Council decide that all new buildings in the region must meet the passive house standard or equivalent.

The buildings we plan today should still be in use in 60 to 100 years or more. The decisions we take will determine whether they're part of the problem or part of the solution to this century's defining issue: climate change.

With the world's governments set to meet imminently at COP21 to attempt to reach binding targets for emissions reductions, the advice from the Intergovernmental Panel on Climate Change's 5th assessment report seems apposite. "Due to the very long lifespans of buildings and retrofits there is a very significant lock-in risk pointing to the urgency of ambitious and immediate measures. […] The urgent adoption of state-of-the-art performance standards, in both new and retrofit buildings, avoids locking-in carbon intensive options for several decades." The report singles out the passive house standard as one of a few key climate change mitigations options for buildings.

But in Ireland, if not the UK, new homes must meet theoretically high energy efficiency specs, and European law requires that all new buildings must be nearly zero energy buildings by 2019 (public buildings) and 2021 (all buildings), so what's the point in pushing for passive?

Part of the problem is that NZEB isn't a defined standard. Each member state must come up with a national definition, using national calculation methodologies – creating enormous scope for confusion. Take the Irish and UK methodologies, Deap and Sap, which will be used to calculate whether dwellings meet the NZEB target. If you built two identical houses in the village of Cullaville, which straddles the Irish border, the one on the south side achieves a 27% reduction in calculated space heating use, because Deap assumes the house is heated for 56 hours per week during the heating season compared to 77 hours in Sap. So must we assume that the occupants of an Irish NZEB will either consume more energy in reality or suffer lower temperatures than a UK NZEB?

Unfortunately we have reason to doubt whether the Irish and British governments' approaches will work. Passive house and precious few other strategies aside, low energy building attempts have a long history of disappointing. For instance, analysis of non-domestic exemplars in the UK has found that energy usage is about twice that predicted. And what's the point investing in energy efficiency if predicted savings don't occur?

The UK has at least recognised this performance gap, and resolved to ensure that new homes perform as designed by 2020 – assuming the Tories don't add this to the list of abandoned green policies. Meanwhile Ireland effectively ignores the issue, with the Department of the Environment arguing that post occupancy research is rare and that "the building regulations do not govern performance in use."

This isn't just about energy either. Performance gaps threaten occupant health, comfort and even the longevity of the building. So we must study the evidence rather than blindly reinventing the wheel, and ensure that the approaches we take to NZEB have been proven to work. In that regard Dún Laoghaire-Rathdown's seemingly radical passive house policy takes on a new light: a sober – even conservative – decision to back a tried-and-tested 25 year old approach to low energy building, instead of relying on minimum standards that may perform well on a spreadsheet, but where real performance isn't a consideration.

Regards,
the editor

Issue 13

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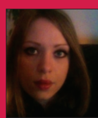
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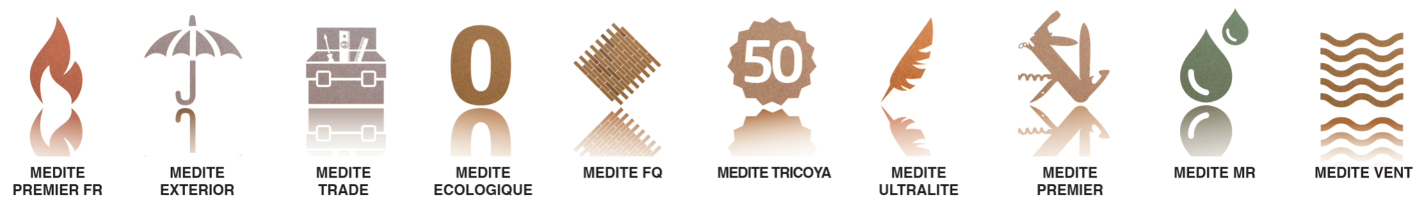

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News

Irish council votes to mandate passive house or equivalent for all new builds

Image courtesy of: Dún Laoghaire Rathdown-County Council/Public-i

One of the four Dublin area local authorities, Dún Laoghaire-Rathdown County Council, has voted that all new buildings in the region must either meet the passive house standard – the world's leading low energy building standard – or other demonstrably equivalent approaches, from next year onwards, in a motion prepared by Passive House Plus editor Jeff Colley. Dublin City Council is set to follow suit, with the same requirement included in its draft city development plan, while Passive House Plus is discussing the same proposal with councillors from Fingal, South Dublin and Wicklow County Councils.

Singled out by the Intergovernmental Panel on Climate Change's 5th assessment report as one of the best climate change mitigation options for buildings, the passive house standard reduces heating demands by 80 to 90% compared to typical buildings, by focusing on careful design and construction, highly insulated and airtight fabric and the use of heat recovery ventilation.

At a meeting of the council on Tuesday, 13 October, councillors voted by 26 votes to 13 to put the clause in DLR's development plan for 2016 to 2022. The motion, sponsored by councillor Marie Baker of Fine Gael, reads:

All new buildings will be required to meet the passive house standard or equivalent, where reasonably practicable. By equivalent we mean approaches supported by robust evidence (such as monitoring studies) to demonstrate their efficacy, with particular regard to indoor air quality, energy performance, comfort, and the prevention of surface/interstitial condensation. Buildings specifically exempted from BER ratings as set out in S.I. No. 666 of 2006 are also exempted from the requirements of Policy CC7. These requirements are in addition to the statutory requirement to comply fully with Parts A-M of Building Regulations.

Dún Laoghaire-Rathdown is the first local authority in the English-speaking world to make the passive house standard a minimum requirement for all new buildings. The criteria are set to become a condition of planning permission in DLR from March next year.

Councillors supported the amended motion despite political pressure from government ministers, the Department of Environment, the Construction Industry Federation (CIF) and Nama to reject the original version – which was less equivocal, in that it proposed to make passive house mandatory, while indicating that alternative approaches may be accepted, and with no "reasonably practicable" clause. Following Dún Laoghaire-Rathdown's decision to include the passive house policy in its draft county development plan in February, environment minister Alan Kelly and housing minister Paudie Coffey wrote to all local authorities in the Dublin region warning them against introducing higher building standards locally in light of the housing crisis.

Legal basis established

Passive House Plus editor Jeff Colley organised a briefing on behalf of the Passive House Association of Ireland for councillors prior to the vote, including case studies by two CIF members – Michael Bennett of Michael Bennett & Sons, and Paul Doran of Pat Doran Construction – on building to the passive house standard at or below conventional build costs. One of Ireland's leading authorities on planning, European and energy law, Philip Lee of Philip Lee Solicitors presented on the legal basis for DLR's proposed policy.

"We can find nothing in law that says that a local authority cannot go for a higher standard than the building regulations," he said.

The Department of the Environment's submission to DLR on the draft development plan suggested that the minister may consider using his powers under Section 31 of the Planning and Development Act to attempt to compel DLR to remove the policy. Such a process would be lengthy, and would only begin once the final development plan is adopted in March, meaning that the minister is unlikely to be in position to see the process through, given the Taoiseach's indication of a general election in the spring.

Lee pointed out that the minister is unlikely to use these powers – because Ireland's building regulations for non-residential buildings are in breach of EU law. With the exception of a minor adjustment to glazing U-values, the energy performance specifications associated with Part L for buildings other than dwellings have remained unchanged since 2005, while the recast Energy Performance of Buildings Directive has required member states to set energy efficiency requirements at or near cost optimal levels since July 2013. A 2013 AECOM report submitted by the department to the commission found that the average non-residential building built to current building regulations had a calculated primary energy demand of 391 kWh/m^2/yr – a full 60% higher than the calculated cost optimal level of 146 kW/m^2/yr.

"Unquestionably Dún Laoghaire or Fingal or Dublin City Council is completely correct to go for a higher standard because we're wrong in law to have regulations that go back to 2005 in terms of what standard of energy efficiency we put in our buildings," Lee said.

"The minister's problem is that the local authority that goes for the higher standard than the current building regulations is meeting the European requirement that the member states have. So it puts the minister in a very hard position to say 'Don't do what Brussels is telling you to do. Go for a lower standard because I'm not quite ready for it.' So I don't think he can actually enforce it. It would be too embarrassing."

DLR also voted to include other sustainable building measures in its development plan, including a motion presented by Green Party councillor Ossian Smyth and Sinn Fein councillor Shane O'Brien that where possible, building materials with low embodied carbon should be used, and guidance on the use of green roofs in response to a motion by People Before Profit councillors Melisa Halpin, Hugh Lewis and Karl Gill.

(above) a still from the DLR's live feed of Cllr Marie Baker making the case for the passive house policy

News

London hosts biggest ever Passivhaus Conference

Photo: Elrond Burrell/Architype

This year's UK Passivhaus Conference was the biggest yet, with over 300 attendees coming to the Business Design Centre in London on Tuesday 20 October, just before Passive House Plus went to print.

The day started with a session on delivering passive house at scale. Architect Jonathan Hines of Architype kicked off, stating that three key reasons behind the success of passive house were the commitment and effort of dedicated people, the collaborative nature of the movement, and perhaps most importantly, the fact that the standard works. He urged designers to reject complex strategies, systems or controls and keep designs simple.

Following the vote by Dún Laoghaire–Rathdown County Council to make passive house standard or equivalent approaches mandatory for new build, Tomas O'Leary of the Dublin-based Passive House Academy spoke, and said that New York was likely to introduce a pro passive house policy soon.

Meanwhile Gwyn Jones of Norwich City Council spoke about that local authority's embrace of the passive house standard for its own social housing projects, saying that fuel poverty was one of its motivations. Jones added that the best way to change the minds of passive house skeptics was to bring them to see existing projects.

Later in the afternoon, passive house consultant certifier Peter Warm spoke about the design of large scale passive house projects. In a detailed speech, he recommended optimising window design for daylight rather than heating, and warned designers not to underestimate the impact of shading, even on tall buildings. Then in his talk on services for large scale passive buildings, engineer Alan Clarke emphasised the need to keep services and controls simple, and said that if a building management system is needed, the services design is too complicated.

In a session on detailed design and construction of large scale projects, Helen Brown of passive house designers Encraft and Paul Jennings of airtightness consultancy Aldas espoused the benefits of hosting a detailed airtightness sequencing workshop with the contractor at design stage.

The day concluded with a question and answers session on how to take large scale passive house development forward in the UK. Tomas O'Leary pointed out there is already a growing uptake of passive house in the UK — even without government support. He said every architecture student should leave university as a qualified passive house designer, and also said more passive house builders were needed.

For a good synopsis of the day, see a Storify page curated by Elrond Burrell at http://tinyurl.com/UKphc2015

(above) Benedict Binns & Gwyn Jones presenting the Norwich Fabric First Framework at the UK Passivhaus Conference

Passive 'Sure House' wins US Solar Decathlon

Stevens Institute of Technology won top honours overall at the US Department of Energy Solar Decathlon 2015 by designing, building, and operating the most cost-effective, energy efficient, and attractive solar powered house at the competition. Dubbed 'Sure House', the building also meets passive house standards for heating demand and airtightness and features heat recovery ventilation.

The Solar Decathlon is a competition that encourages college teams to design, build and operate solar-powered homes.

Inspired by Hurricane Sandy, the house takes a new direction in storm-resilient coastal housing by combining the architectural feel that characterises the Jersey Shore with 21st-century technology and fibre-composite materials repurposed from the boat-building industry, which can repel storms as well as everyday saltwater.

The Sure House is based on three principles: use less energy through smart design, generate all energy needed through renewable solar electric, and be capable of providing power during electrical outages.

Sure (meaning sustainable and resilient) House is a high-performance, solar-powered house that is armoured against extreme weather, and can provide emergency power in the aftermath of a power cut through its solar PV inverter and external USB charging sockets.

Photo: Thomas Kelsey/U.S. Department of Energy Solar Decathlon

The notion of the "shore house" resulted in a focus on indoor-outdoor spaces, and through a simple design transformation, the dwelling doubles its usable space in the summer months by opening up to the outdoor decks.

This outdoor living room complements a contemporary interior that draws on natural daylight and flexible living space to create an inviting family home. Working with local topography such as dunes, the Sure House can also be raised slightly to avoid periodic nuisance flooding and encapsulate vital building systems in a storm-resistant shell.

Following Solar Decathlon 2015, the Sure House will be delivered to a Jersey Shore town, where it will become a community outreach centre and information resource.

(above) Stevens Institute of Technology's Sure House, a Hurricane Sandy inspired project that won the 2015 US Solar Decathlon

News

DVS adds high profile passive houses to its roof light portfolio

DVS (Daylight & Ventilation Solutions) — supplier of Lamilux passive house certified roof lights — has recently completed its latest high profile passive house projects, the striking Oyster Falls coastal home in Devon and the University of Leicester Centre of Medicine.

DVS is the first UK roof light supplier to achieve phA advanced component Passive House Institute certification, and has been a member of the Passivhaus Trust since 2012.

DVS offers two different certified passive roof light products, both manufactured in Germany by Lamilux, one of Europe's leading roof light specialists. The Lamilux PR60energysave glass roof system sets the benchmark for energy efficient large area atrium glazing with a total product Ucwi-value of between 0.81 and 1.0 W/m²K. For smaller areas, the company's FEenergysave flat roof skylights deliver a Usl-value of less than 0.84 W/m²K.

As well as state-of-the-art thermal performance, both systems offer excellent aesthetics with a wide range of sizes, options and accessories.

Daniel Boughton, DVS managing director, said: "The passive house concept is fast becoming mainstream and we believe that roof lights will make an increasingly important contribution to achieving passive house status in both domestic and commercial buildings."

DVS has recently supplied roof lights for a variety of buildings throughout the UK, from a large PR60energysave glass roof at the University of Leicester's new Centre for Medicine — the UK's largest passive house building — to many private homes. These include Oyster Falls, and Springfield House by Wilf Meynell of Studio Bark, which was featured on Channel 4's Grand Designs' programme.

DVS recently made their fourth consecutive appearance at the UK Passivhaus Conference. The company will also be exhibiting at the Passivhaus Pavilion at Ecobuild 2016. For more information, please visit www.dvsltd.co.uk

(above) Oyster Falls, Croyde, Devon

Darren O'Gorman joins Ecological Building Systems

Ecological Building Systems has announced the appointment of Darren O'Gorman, formerly of passive house training and consultancy firm Target Zero, to its technical team.

"Ecological Building Systems has pioneered intelligent airtightness and wind-tightness systems, and natural thermal insulation solutions for 15 years," said Niall Crosson, technical engineer with Ecological Building Systems. "From the outset the company recognised the need to back up high quality products such as pro clima and Gutex woodfibre with state of the art technical support and training. Darren trained the first passive house tradespeople in the UK to be awarded certification from the Passive House Institute. The addition of Darren to Ecological's technical support team, reaffirms the company's commitment to provide market leading products backed up by first class technical support."

Meanwhile Darren O'Gorman commented: "Over the last number of years delivering passive house training and consulting, I found many construction trades and professionals were not fully aware of the benefits of using both natural building materials and the importance of airtightness and proper ventilation. I felt this was a weak area in the industry. Also having liaised on many low energy and passive house projects, many of which used products from Ecological Building Systems, I was hugely impressed by what could be achieved by both using excellent materials and quality installation by experienced and trained installers."

"This I feel is one of the key elements to achieving a certified passive house project, along with superior quality workmanship, and the builders having an excellent knowledge of materials. When the opportunity arose for a technical support engineer and trainer with Ecological Building Systems I jumped at the chance. With my experience in both training and consulting, along with having a passion for building physics, I look forward to making a positive contribution to Ecological Building Systems. I am very much looking forward to working with the Ecological team and look forward to expanding their award winning training programmes and assist in the development of their new state of the art training centre at their UK headquarters in Cumbria."

In other news Ecological Building Systems joined The Green Register for their 15th birthday celebrations at Bristol Aquarium on 22 October. Ecological provided a presentation and practical workshop titled 'Achieving airtightness — why and how: the need for joined-up thinking for joined-up building!' in conjunction with The Green Register in London on 23 October.

(above) Passive house specialist Darren O'Gorman, who has joined Ecological Building Systems' growing technical team

News

Smet launch new moisture regulating, anti-mould plaster

Photo: Katarzyna Bialasiewicz, photographee.eu

Smet Building Products, the agents for leading German manufacturer Casea, has introduced the latest in internal moisture regulating plasters: Casea Casucalc Klima and Casea Klimafeinputz KFP breathable fine finishing plaster.

Klimafeinputz KFP is unique in that rather than being a pure cement or pure gypsum based plaster, it combines the properties of gypsum, lime and clay. The product's special composition — consisting of clay, fine white lime, fractional sands, marble powder and Casul white pigment — allows the product to breathe and provides high level of protection against mould growth, without the use of chemical additives.

Klimafeinputz KFP permits constant hygrometric exchange between the substrate and the environment. It is highly breathable and regulates moisture in the air by absorbing moisture quickly when humidity is high, later releasing it quickly. Because its natural chemical composition it's particularly alkaline, it helps to prevent mould growth.

"It's widely known that internal wet wall plasters contribute to achieving airtightness. What is less well known is that choosing the right plaster can not only provide airtightness but can also can play a major role in improving internal environmental comfort by ensuring constant hygrometric exchange between the substrate and the environment," said Joris Smet of Smet Building Products. "Sourced naturally and ecologically, the components of lime and clay combine for excellent technical properties, offering moisture absorption, moisture regulation, strength and protection against micro-organism growth."

Smet said Klimafeinputz KFP is extremely versatile and can be applied onto all common base coats such as lime-cement, cement, gypsum, gypsum-lime, gypsum lime-clay and clay plastering renders, as well as onto plaster boards. The addition of Casul white pigment means the dried finished plaster has a very bright white colour, so painting is not mandatory. However if a colour finish is required, and in order to facilitate maximum breathability when painting, compatible silicate, lime or clay based paints are recommended.

Casea Klimafeinputz KFP is a factory produced special white, mineral fine plaster CS that meets EN 998-1 and is suitable for indoor use. "It's pre-mixed and supplied in ready to use 25kg buckets with a smooth finish," said Smet. "The addition of the natural binders allows a long open time, ensuring the perfect finish is achieved." As a finish skim coat, it's ideal for final finishing of Casea Casucalc Klima as a basecoat and CASEA Bauprotec renders and plasters where a smooth finish is required. Being a strong plaster, it can be used in kitchens and bathrooms where tiling is required.

(above) a living room plastered with Smet's new Casea internal moisture regulating plaster

Kingspan Optim-R achieves BDA Agrément cert

Photo: Daniel Burton

The thermal performance of the Kingspan Optim-R panel has now been independently verified as it became the first vacuum insulation panel to be granted a BDA Agrément certificate.

The demanding certification ensures the product is fit for purpose and is recognised by professional bodies such as the NHBC and LABC. This can help to fast-track procedures and approvals, saving both time and cost for all involved, according to Kingspan.

The certificate is issued by BDA Advies, part of the Kiwa Group, an internationally respected institute with over 30 years of experience in testing and inspecting materials for use in the building envelope. Its independent assessors carefully examined and tested all aspects of the Kingspan Optim-R panel, from manufacture to installation. Their full findings can be viewed on the Kingspan Insulation website.

With a proven aged-design value thermal conductivity of 0.007 W/mK, the certificate "confirms that Kingspan Optim-R panel can far out perform the next best insulation product", according to the company. It also contains installation guidance, R-values and typical details for all Kingspan Optim-R system applications.

As a further mark of the rigour and quality of the BDA Agrément scheme, all results are audited and verified annually. Kingspan said this means, when installed according to Kingspan's guidance, you can have complete confidence that all Kingspan Optim-R systems will perform as expected.

(right) Kingspan's Optim-R vacuum insulation panel offers an aged-design value thermal conductivity of 0.007 W/mK

News

18 passive house apartments break ground in Staffordshire

Work is underway on 18 new passive house apartments in the grounds of St John's Hospital in Lichfield, Staffordshire.

St John's foundations go back to the twelfth century and it has one of the most significant Tudor buildings in the country, which now provides comfortable and secure accommodation for older people who can live independently. The project is designed by KKE Architects, with passive house and M&E design by Encraft, and will be built by Paragon Construction. The client's representative is Greenwood Projects Lichfield.

The new units will provide modern accommodation that offers independent living to older people, with neighbourly support and care easily available.

The apartments will be constructed around a central courtyard area, and the building will comprise two wings, one with fourteen one-bedroom flats and one with four two-bedroom flats.

The smaller wing will be thermally separated into two blocks, and all three building envelopes will go for passive house certification separately. The buildings will be constructed from a cavity wall – insulated with mineral wool – with a brick finish externally.

The project is also set to be the first multi-unit residential development in the UK with a centralised heat recovery ventilation system and heating system. The heating and hot water for all 18 apartments are provided by two 30kW gas boilers with SAV flat station heat exchangers in each apartment. The larger wing will have a centralised MVHR system servicing the apartments.

(above) the 18 unit passive house project in Lichfield, Staffordshire will feature a centralised MVHR and heating system

Shipping container becomes high-quality accommodation for homeless

Eco ICID flues manufactured by Schiedel Chimney Systems have been used in a charity project converting a redundant 40ft shipping container to create Ireland's first shipping container home, which will go to provide accommodation for the homeless in Cork. The project is the brainchild of a group of 60 professional craftsmen and construction companies in Ireland. The consortium took three days to convert the container to a temporary home for a homeless family.

Known as Project Ripple, the container was transformed in the grounds of the Irish Museum of Modern Art, in Kilmainham. The fully completed home was donated to the society of St Vincent de Paul, and was transported to Cork to provide accommodation for those who would otherwise be homeless.

Sean Byrne, Schiedel area sales manager, believes the project offered a unique, challenging and worthwhile cause, saying; "This is one of the more unusual projects which we have been involved in. We were delighted to be able to support this charitable project, the first of its kind in the Republic of Ireland.

"We had very tight deadlines and worked together with the team to complete the project. This was an excellent initiative to be involved in to demonstrate the diversity of projects we can work with. It was a real pleasure and honour to work on this project with such a high profile architect as Derek Trenaman from Ceardean Architects and the Ripple Construction Team."

This flue was chosen specifically as it benefits from a wide range of fittings and adaptors to offer flexibility and to tie in with any solid fuel appliance. Every element of the Project Ripple build was donated or sponsored, including Ampack airtightness products and a Lunos decentralised heat recovery ventilation system from Partel, Smartply OSB, and phenolic insulation from Kingspan, resulting in uniform U-values of 0.17 for walls, roof and floor.

Schiedel Chimney Systems is the UK's leading manufacturer of stainless steel chimney systems, and manufactures the world's first passive house certified chimney system.

(above) Project Ripple, which involved turning a shipping container into low energy accommodation for the homeless

News

Passive Sills puts finishing touch to K Club extension

A Cork-based manufacturer of passive window sills has recently completed the fabrication of all decorative mouldings for a new 70 bed extension at the prestigious K Club resort in Straffan, Co Kildare.

Poly Passive Mouldings Ltd, trading as Passive Sills, manufactured all the external decorative mouldings as replicas of the original features of Straffan House, the 1830s mansion on the site of the luxury five star hotel. The K Club famously hosted the Ryder Cup in 2006.

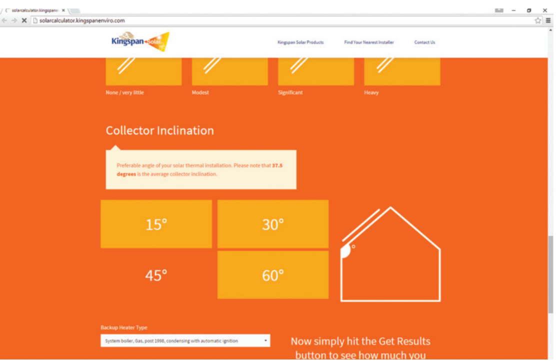
The new extension was designed in the style of the original building, and was constructed from precast slabs which were externally insulated with EPS. External insulation contractor Kilsaran contracted Passive Sills to provide all the mouldings, all of which were made from polystyrene and finished with a stone resin.

Passive Sills is a Midleton, Co Cork-based manufacturer of thermal-bridge free window sills and mouldings that are suitable for all construction types. Its polystyrene sills are lightweight and moisture resistant, but capable of supporting a quarter tonne of weight on a one metre section. The company was founded two years ago by Patrick Beausang and now has its own 4,000 square foot factory.

Passive Sills has also recently launched its new passive sill with a natural granite resin exterior, for a natural stone finish.

(above) thermally broken decorative mouldings manufactured by Passive Sills feature at the externally insulated K Club extension

Kingspan launches online solar calculator



There are significant savings to be made with a well designed solar thermal installation, using either flat plate or vacuum tube collectors, and Kingspan Solar has taken a major step towards clarifying exactly how much. The company's new online calculator quickly works out the cost benefits over time based on a few simple pieces of information about the homeowner's existing heating system.

The web-based calculator will be useful for a wide audience to demonstrate the financial reasons for choosing a solar thermal heating system.

Comprehensive training provision and an accredited installer scheme have been cornerstones of the Kingspan Solar offer and now the on-screen calculator can help convince often sceptical consumers to invest in solar thermal energy.

Of course, armed with some basic criteria such as property size and location, roof orientation and details of the supplementary heating system, homeowners can work this out for themselves. However, the Kingspan site also generates a search for recommended Kingspan Solar accredited installers with the qualifications to fit a solar thermal system, and so will also provide the platform for accredited installers to capitalise on new business opportunities.

Kingspan believes that online availability makes the calculator immediately accessible to installers who, increasingly, use their smartphones and tablets as essential business tools. The calculation, which takes into account the value of an annual renewable heat incentive (RHI) payment in the UK, and shows total income over the seven year RHI period and the overall savings over the lifetime of a solar thermal system (25 years), will allow installers to convert many people who may not have previously considered solar thermal.

"It's a very positive message from Kingspan Solar," says the company's solar technical lead, Finbarr McCarthy, "underlining our confidence in the market and commitment to every stage of the specification process"

He continued: "By showing clearly what homeowners can save, the calculator will not only support solar installers in front of their customers but ultimately drive renewable energy demand and push our whole industry more closely towards its environmental goals."

Kingspan Solar will be promoting its online solar thermal calculator to installers, homeowners and architects throughout the UK and Republic of Ireland. You will find the calculator at http://solarcalculator.kingspanenviro.com/

(above) a screenshot of Kingspan Solar's new online solar calculator

News

AECB groups visiting groundbreaking projects nationwide

The Association of Environment Conscious Building (AECB) has a network of local groups across England, Scotland and Wales that organise events and provide an opportunity to meet with AECB members in your region. Here is an update on what they have been up to recently.

Pedalhaus Tour de Kent
AECB members in Kent took to their bikes on a sunny in late August for a straw bale fest. With three different straw bale properties to visit and a modest cycle on fairly level ground, the tour appealed to all, providing plenty of time to socialise, network and learn.

The first building was complete – an elliptical building with passive house levels of airtightness, and totally hand built. The second building visited was a 90% finished teaching-block using load bearing bales with a PV roof, and finally the cyclists arrived at an oak framed house under construction with straw bale infill walls being self-managed.

Next on the agenda for the Kent group is making Kent peg clay tiles on Romney Marsh – keep an eye on the local group page of aecb.net for more details.

Cornwall local group
The Cornwall group made the most of the autumn sunshine to visit two construction sites during September. Barnaby Shepperd invited the group to his retrofit in Falmouth to see the graphite EPS external wall insulation being applied. There are plenty of awkward details that the installer (Home Green Home) has had to overcome, and it was also interesting to hear his views on the types of EWI systems, and how the current state of government funding for retrofit has affected his business.

At the end of September, Ecofab Ltd invited Cornwall AECB members to its Dental Precision project in St Agnes, Cornwall. This 300 square metre new-build dental surgery uses Ecofab's pre-insulated panel and glulam frame system to achieve very low environmental impact, and cost around £1600 per square metre.

The system upcycles straw and sheepswool as insulants, it is membrane free and has a suspended timber floor structure with small pad foundations and achieves excellent levels of airtightness and thermal performance.

The next meeting of the Cornwall local group will be on 2 November in the Borough Arms, Bodmin where Green Building Store will be presenting a CPD entitled 'Passive house design and specification'. Email Cornwall group co-ordinator Nick Donaldson if you are interested in attending (nickdonaldson@arco2.co.uk).

Three counties local group (Gloucestershire, Herefordshire and Worcestershire)
The season kicked off in May with a visit to Deb Turnbull's house in Colwall. The project is a deep retrofit aiming for the Enerphit standard. It's a work very much in progress, including a SIP extension with timber cladding, triple-glazing, a loft conversion, hemp-lime, cork and expanded glass insulations.

A balmy evening in July found group members on the English/Welsh border at the Pontrilas Wetland, designed and constructed by Biologic Design Ltd. This is a two-acre constructed wetland for rainwater runoff attenuation plus a new five-acre constructed wetland to mitigate the loss of up to 14 acres of prime Herefordshire agricultural land that was recently developed.

A month later and the group were at Living Green, Bourton-on-the-Water. This project is open to the public, based on deep thinking about sustainability principles, and it hopes to inspire the general public with new ideas for our existing housing stock.

A town-centre Cotswold stone house has been upgraded with a menu of ideas for retrofitting, as well as some new-build, in the hope that people will see something they can relate to their own home.

Features include an extension with a grass roof, underfloor heating, solar thermal and PV, rainwater harvesting, an organically managed garden full of wildlife, climate change awareness measures, natural paints and wood treatments to minimise toxic load in the house, clever re-using of all kinds of things (with humour), water saving measures, sheep wool insulation and much more.

In September, Group members were fortunate to make an unscheduled visit to architect Sandy Hickey's earth sheltered house, Applewood, in the Cotswold village of Burford. A stepped design on four levels allows the house and garden to take full advantage of the south-facing slope for light and heat. The house is of concrete construction, covered with an insulating waterproof 'umbrella' laid over and beyond the house, creating a large dry underground inter-seasonal heat store around it. It has an indoor swimming pool heated by a ground source heat pump, which also provides some of the domestic hot water and underfloor heating. An MVHR unit serves both the house and the swimming pool.

At the time of writing the group planned to make a 15 October visit to Cirencester to see the conversion of a theatre into a youth hostel, to the Enerphit standard, designed by Potter and Holmes Architects. It is the first youth hostel in the country built to the passive house standard.

For your own local AECB info, visit www.aecb.net or contact gill@aecb.net. A longer version of this article will be published at www.passivehouseplus.co.uk.

(above) AECB local group members visiting an oak-frame house under construction in Kent; the Pontrilas wetlands; and learning about the sustainable M&E spec at Sandy Hickey's house in the Cotswolds

News

28 unit passive house scheme completed on Isle of Wight

Southern Housing Group, one of the largest housing associations in the south east of England, has delivered its first ever scheme built to the passive house standard. Built on a 1.5 acre site, Cameron Close is a £4.2 million development of 16 semi-detached family houses and 12 sheltered apartments in Freshwater on the Isle of Wight.

All of the homes on Cameron Close have been built with 500mm thick external walls, have triple-glazed windows, a ventilation system with heat recovery, and low capacity condensing boilers to provide hot water and minimal top-up space heating.

The family houses feature front and back gardens, the apartments have landscaped kitchen gardens and the entire site has been designed to encourage a cohesive community.

Alan Townshend, development director at Southern Housing Group, said: "We decided to make Cameron Close a passive house development as it best meets the group's sustainability objectives[…].

"Given the current focus on sustainable housing on the Isle of Wight, we decided to take the opportunity to redevelop one of the Group's existing sheltered housing schemes. We moved our current residents to a new modern sheltered housing scheme, Whitmore Court, that best met their needs and used the existing site to create these environmentally friendly family homes.

"The Isle of Wight Council supported our approach and provided us with some supplementary funding to help us achieve the passive house standard.

"As part of our aim to provide sustainable tenures, the group is always looking at how we can improve the quality of the homes we provide, so not only does this fabric-first approach provide an environmentally friendly solution for building these homes, it will also give the residents of Cameron Close significant and long-term savings on their energy bills.

"Our initial estimation is that the entire scheme could save up to £25,000 a year in energy costs, with some residents being able to save up to £900 in a three-bedroom home." The development is currently awaiting passive house certification.

The group is carrying out detailed post-occupancy monitoring, in association with passive house consultancy Warm, to study the performance of the houses.

(above) the 28 unit Cameron Close housing scheme is awaiting passive house certification

Partel set to launch new semi-centralised heat recovery unit

Passive building supply specialist Partel is to launch the new Lunos Nexxt semi-centralised heat recovery ventilation system to the Irish & UK markets.

Nexxt is a decentralised heat recovery unit that combines the benefits of both ductless decentralised and centralised control systems. It enables control of ventilation in several rooms via just one unit, and is also the most silent unit of its kind, according to Lunos.

Nexxt achieves heat recovery efficiency of up to 90%, and heat transfer is made via a cross-flow heat exchanger or optionally via a cross-counter-flow heat exchanger. Power input commences at five watts and volume flows of over 90 metres cubed per hour can be generated.

Nexxt is rounded off by a completely new operating concept. Piezo elements are located behind an elegant metal facing which ensures that clear but silent feedback is provided on actuation by means of vibration and sound.

Nexxt is controlled via humidity or temperature sensors as standard, and optionally also via a CO_2 sensor. It is installed directly into the outside wall — a surface and flush version are available. The well-proven 160mm tube is used for connection to the outside, meaning just one penetration of the airtight layer is needed.

(left) the Lunos Nexxt semi-centralised MVHR system, available in the UK and Ireland via Partel

News

Passive buildings across Europe to open their doors this November

Photos: Marco da Cruz & Sean Burke-Daly

Low-cost, comfortable, sustainable – that's the future-proof formula for the buildings of tomorrow. During the International Passive House Days from 13 to 15 November, everyone will be able to see this concept in action, when several hundred passive house buildings across Europe open their doors to the public.

Experts will demonstrate how these buildings function, while occupants will talk about their experiences of living and working in them. An overview of the passive house buildings participating in the event can be found at www.passivehouse-database.org

Most of the participating buildings are private residences, but office and school buildings will also feature. "During visits, everyone will be able to see for themselves that a passive house not only saves energy but also provides high levels of comfort and air quality," said Amina Lang of the International Passive House Association.

For details of participating UK buildings and how to register to attend, visit www.passivhaustrust.org.uk. The event also coincides with the NZEB Open Doors event in Ireland, which will see low energy buildings more widely open their doors to the public. For more information, see www.nzeb-opendoors.ie

Passive house ventilation systems awards launched

Meanwhile, the Passive House Institute has announced the launch of its 2016 Component Award for ventilation solutions in residential buildings. The award will be presented at the 20th International Passive House Conference, which will be next April in Darmstadt, Germany.

The award will place a particular focus on life cycle costs — for the device itself, but also for components, ductwork, installation, and other expenses such as casing or suspended ceilings.

All ventilation units which have been certified by the Passive House Institute can be entered. Innovative solutions for step-by-step retrofits can also be submitted even if these are still at the prototype stage.

The entry deadline is 31 December 2015. This competition is part of the EU-funded Europhit project. Further information about this EU project and the component award is available online at www.europhit.eu

(above) passive buildings across the UK and Ireland will be accessible on the International Passive House Days from 13-15, including the Sjolander da Cruz-designed River Studio office retrofit in Birmingham and a Young Design Build Enerphit in Slane, Co, Meath

Passive house conference comes to Cork this November

The Passive House Association of Ireland has announced that its second See the Light conference for 2015 will take place on 13 November in Cork.

"This year we are delighted to bring our conference to Cork and the wonderful Architecture Factory at Cork Institute of Technology," said association chairman Dr Shane Colclough, Ireland's first passive house PhD. "This is a fabulous space which has been made available to us by Cork Institute of Technology and we wish to thank them in advance for all their assistance in bringing this event to Cork."

The southern region has embraced passive technology with a fifth of PHAI members coming from this part of the country. The event coincides with the national NZEB Open Doors weekend, which will see low energy buildings across the country opening their doors to the public, and follows on from the inaugural Northern See the Light conference on 24 September, held by the PHAI's northern chapter at the Centre for Renewable Energy and Sustainable Technologies in Enniskillen.

The event will be focused on passive house construction in the region, with local passive house component manufacturers Cygnum and Munster Joinery serving as the main sponsors. Additional support comes from platinum sponsors Coillte, gold sponsors Partel, silver sponsors Amberline and bronze sponsors Future Generation Solar.

The winner of the PHAI's second annual student design competition – sponsored by Coillte – will also be announced and displayed at the conference.

Tickets and more information on the programme are available from www.stl.phai.ie. Tickets are limited so early booking is recommended.

(above) CIT's Architecture Factory, the venue for the 2015 See the Light conference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When it comes to passive house design, there is no substitute for experience

*A combination of on-site and design experience is crucial to meeting the passive house standard as seamlessly as possible, says **Bram de Bruycker** — and it can also help to save you a lot of money.*

Using PHPP, the passive house design software, at the very early stages of any new project is crucial to meeting the standard. There must be good interaction between the client, the architect and the passive house design specialist. Obviously those last two roles can be combined in one individual — or in one office — but the result should be an affordable passive house scheme that is ready to be constructed.

However, what often happens is that the client doesn't know exactly what passive house means, and sometimes the architect is looking to take on a new adventure, designing his or her first passive house. The expression 'learning by doing' is a good way to make progress in life, but when it comes to building a passive house, it makes sense to learn from the mistakes others have already made. We all know that building a house is a huge challenge for any family, and those who are bold enough to want to build a passive house shouldn't have to be guinea pigs for such a crucial matter as PHPP calculations.

Taking on board a PHPP specialist with on-site experience is far better than trying to get it right without such an expert, and ending up with an exploded budget and no passive house at all. During my 15 years of passive house experience in Belgium and two years in the UK, I have seen so many PHPP calculations being far from optimal – leading to unnecessarily onerous U-values and potentially expensive build costs. This was not because the designers who entered the data did not understand the PHPP spreadsheet, but because they may not have had enough practical knowledge and experience. In these cases PHPP wasn't being used to identify elements of the design which were causing problems, and it wasn't being used to identify high cost elements and converting them into high efficiency building solutions instead.

I'll give you an example: a beautifully designed house with a slightly difficult orientation — but still capable of meeting the passive house standard. The U-values in PHPP came out at 0.09 for the floor, 0.08 for the walls and 0.06 for the roof — far below the suggested passive house figure of 0.15. Meanwhile the windows had glazing U-values of 0.7 and 0.8 with frame U-values of 1.2 and 1.6 — far above the suggested overall window U-value of 0.85. On top of that there were several very small windows, which lose significant heat but have almost no solar gain.

The result is a very high envelope cost — thick floor, walls and roof, and mid-range windows. This is an example of how to achieve the passive house standard in theory, but without practical thinking, leading to a disappointed client (if he or she is able to pay for all this).

We all know by now what the most common PHPP mistakes are (divided windows being entered as one element, under/over-estimated shading input, too low ventilation rates and default altitude settings). But what about the design hiccups that are made when the first pencil sketch comes out of the architect's hand? Orientation and compactness of the dwelling are hugely important. We need the right balance between heat gains and heat losses and even though we often can't choose the orientation on the plot, we can design the inner layout of the house towards the sun. That's why a pre-designed house off-the-shelf can be a passive house on one plot and not achieve the standard on another.

A stubbornly held misunderstanding is that compactness is linked to small size, but nothing is less true. The compactness is the external surface area to internal volume ratio, therefore it is more complicated to achieve passive house standards with a small dwelling, and designing houses as detached rather than attached makes a huge difference.

At the design stage of a passive house, it is an unwritten rule to put an airtightness figure of 0.6 air changes per hour at 50 Pascals into PHPP — but in reality we simply don't know what the end result will be, or how precisely the builders will work. Even if they follow the design precisely, they might not get the necessary airtightness result. The smaller the dwelling, the larger the ratio of exposed envelope to treated floor area, the more important it is to use a better airtightness layer.

A long time ago in Belgium, still being pioneers in passive house construction, we copied a lot of proven solutions from our German neighbours, who were far more advanced than us in the passive house construction methods. We used OSB 3 to create our airtight layer on the floor, walls and roof and taped every single junction with enormous precision, but we didn't achieve the 0.6 air changes per hour result. The problem was very simple: the OSB wasn't airtight enough for such a small floor space.

We tested the OSB by taping an airtight membrane over it off-site and indeed saw the membrane bursting outwards quite a bit. We had to give it a double coat of varnish to achieve the required result. Subsequently, we developed a new vapour barrier panel for airtightness and lateral stability which is now used on all our 'naked house' projects. This highlights how on-site experience is as important as design experience. Without the on-site experience, projects can end up with very high costs and delays caused by trying to solve problems when the construction is already underway.

Bram de Bruycker is technical director of Naked House Ltd.

"We need the right balance between heat gains and heat losses and even though we often can't choose the orientation on the plot, we can design the inner layout of the house towards the sun."

Passivhaus by Kingspan

The new Kingspan Passivhaus has been designed by HTA Design LLP in collaboration with Potton.

The idea behind the design of the housetype was to defy the stereotype that Passivhaus will not work with generous openings and a form that deviates from the typical boxy design with small windows.

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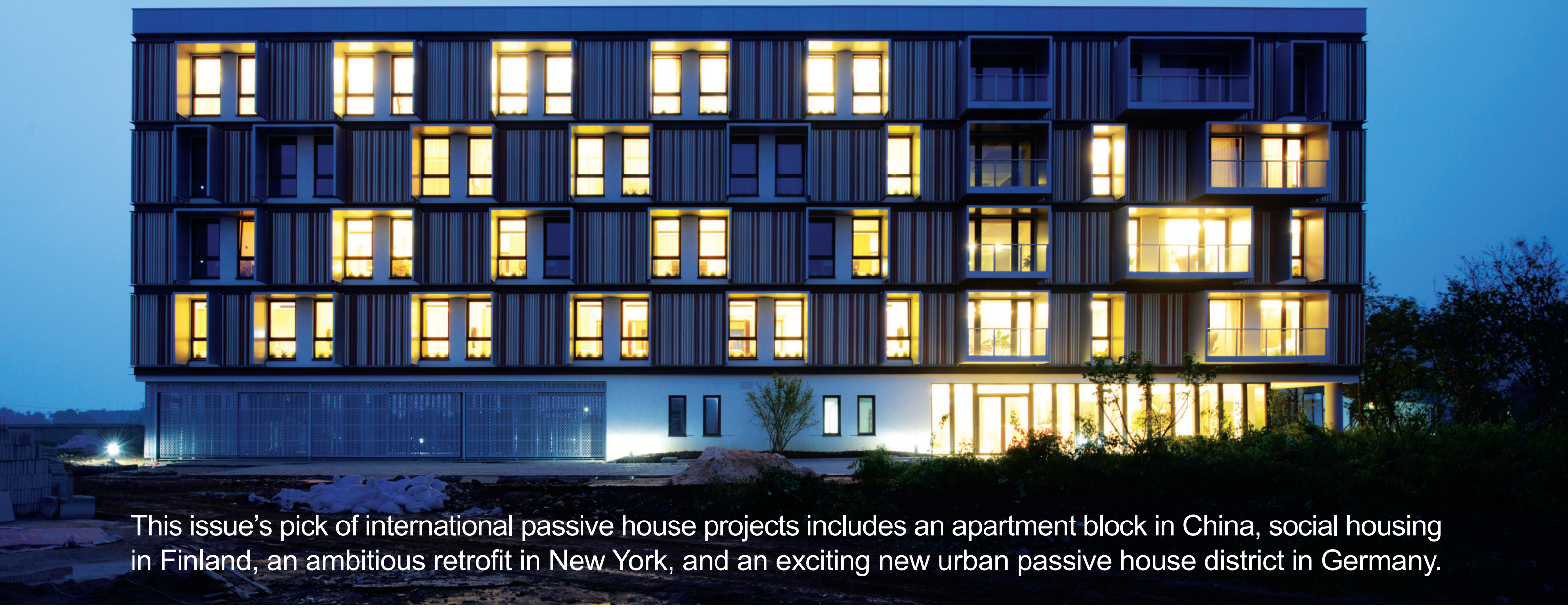


This issue's pick of international passive house projects includes an apartment block in China, social housing in Finland, an ambitious retrofit in New York, and an exciting new urban passive house district in Germany.

Passive House Bruck, Zhejiang, China

Located in the hot and humid south of China, Passive House Bruck has to cope with outdoor temperatures that top 40C and humidity regularly above 90%. These were among the central challenges for designers Peter Ruge Architekten.

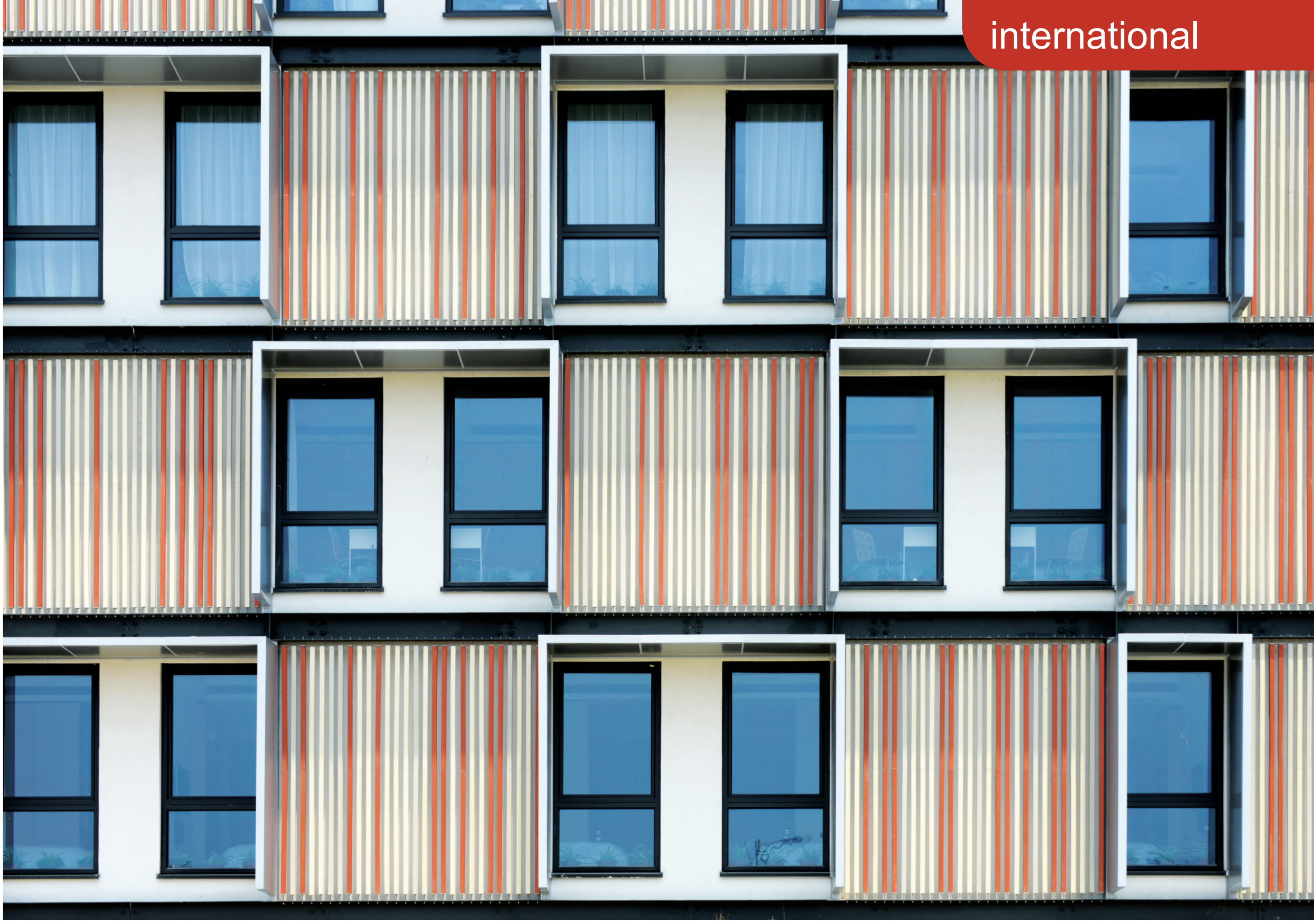
The building was commissioned by the Chinese Landsea Group, a private developer eager to experiment with sustainable building systems. Completed in the summer of 2014, the five-storey building houses a total of 36 one-bedroom apartments, six executive suites and four three-bedroom 'model' flats, which are open for interested families to live in for short periods, to experience living in a passive house.

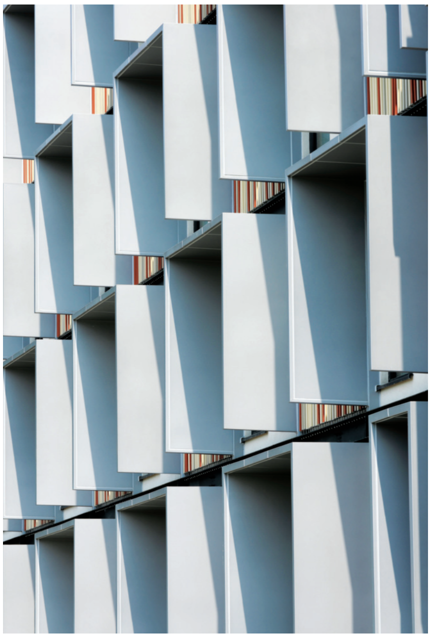
The building was constructed with lightweight concrete that was then externally insulated with polystyrene, and clad with vertical terracotta bars that provide shading. The building features three heat recovery ventilation units plus a heat pump system that delivers heating, cooling and dehumidification. There's also 66 square metres of solar thermal panels that deliver hot water to the apartments.

Passive House Institute founder Dr Wolfgang Feist spent a night in one of the model flats, and commented: "A very large part of the global construction activity is currently taking place in China; consequently, it is all the more pleasing that the advantages of the passive house standard are also being recognised here."

Passive House Bruck is the first certified residential passive house in southern China, and according to its architects, it achieves an approx 95% energy saving compared to conventional Chinese dwellings. ▶

Photos: Jan Siefke





Bahnstadt passive house district, Heidelberg, Germany

Bahnstadt is a new passive house district on the site of a former freight yard in Heidelberg, south-west Germany. In 2010, the city council mandated that all buildings constructed here must meet the passive house standard (though some exceptions are allowed).

Bahnstadt covers 116 acres on the banks of the River Neckar. It is one of Germany's largest urban development projects, and the largest passive house district in the world so far. The local energy agency models each new building in PHPP, the passive house design software, to make sure it meets the standard.

To date 150,000 square metres of floor space has been constructed, including apartments, student accommodation, a hotel, day care centre, shops, offices and labs. Another 150,000 square metres is now in the works.

All of the district's heating and electricity is supplied by a wood-fired combined heat and power plant. Sustainable transport is easy here, too: the district is near the city centre, train station and tram network, and has well-designed walking and cycle paths.

In 2014, the average energy consumption for space heating across Bahnstadt's 1,260 residential units was 14.9 kWh/m²/yr — remarkably close to the passive house standard of 15. And once it is fully developed, up to 12,000 people will be living and working in this new city district. ▶

Photos: Steffen Diemer & Christian Buck (main image & bottom right)

Oravarinne passive houses, Espoo, Finland

Oravarinne – meaning Squirrel Hill – is the name of the suburban street in Espo, southern Finland, where these three colourful new passive homes were built.

The dwellings were a pilot project by TA Yhtymä, a social housing association, to see how well suited the passive house standard was to the region's cold climate, and how practical it was to build them here.

The project showed that it is possible but "not yet the economic optimum", according to its designers Kimmo Lylykangas Architects. "For that, better products, especially windows, have to enter the market first."

Indeed, meeting the passive house standard here demanded a super-insulated building envelope. The walls were constructed with reinforced concrete that was then insulated externally with 400mm polystyrene, while the attic features over 600mm of mineral wool. All the windows are quadruple-glazed.

Each of the buildings has a simple compact form — minimising the surface area from which heat can escape — surrounded by a terrace. The depth of the terrace varies depending on which way each facade is facing. For example, deep south-facing terraces provide shade in summer, but still let in the lower-angle sunlight in winter. Meanwhile, generous glazing provides views to the development's wooded surroundings. ▶

Mamaroneck Enerphit, New York State, USA

This upgrade and extension to a family home in Mamaroneck, New York, was recently certified to the Passive House Institute's Enerhphit standard for retrofit projects.

The original two-storey timber frame building was constructed in 1963. The upgrade, designed by AM Benzing Architects, involved removing the existing roof and constructing a brand new second floor. The entire structure was then externally insulated and finished with new ventilated cladding, while the new roof is insulated with cellulose (recycled newspaper).

A new south-facing timber pergola provides shade in the summer time while letting the low sun provide solar gain in winter. The renovated house is now heated and cooled by a Mitsubishi air-source heat pump, while a separate heat pump provides hot water, and there's a new natural gas stove too.

The house has 28 rooftop solar photovoltaic panels now too, and the garage has a charging station for electric cars. There's also mechanical heat recovery ventilation, as is standard for passive houses in cooler climates, which captures heat from stale air and uses it to preheat incoming fresh air. ▶

Photos: Korin Krossber/PlanOmatic

“The house feels super healthy,” the homeowner says. “I wake up in the morning without the urge of opening a window to ventilate. My indoor air is filtered and completely replaced with fresh outdoor air every three hours. The air does not feel dry compared to what it was with the former heating system and my sinuses are happy which relieves me from the splitting headaches I used to wake up with.”

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DEVON ONE-OFF *PUSHES LIMITS OF PASSIVE*

Huge expanses of unshaded glass are usually a taboo for passive house designers, but with his clients insistent on maximising their wide-angle coastal panorama, this project's architect found clever ways to integrate the passive house approach with wrapping the house's ground floor in glass.

Words: John Cradden

If you were building a large house with south-west-facing views over a beautiful bay stretching out to the Atlantic ocean, it's natural that you'd want to have a design with lots of glass to make the most of the stunning vista. Sure enough, this two-storey, four-bed passive house in Croyde Bay in north Devon, England, has huge expanses of glass on the ground floor.

Of course, there is a balancing act between glazing and shading if you don't want a house like this to overheat on sunny days, but owners Rupert and Charlotte Hare were adamant that they didn't want their views of the bay restricted in any way.

But they were also keen that their new home, built on the site of Rupert's grandmother's old four-bed bungalow, meet the passive house standard, partly because of the difficulty in getting basic utilities like gas to the remote location, and because of the expectation that energy prices would rise in the future.

So how did they reconcile a demand for unimpeded views with a desire to build a passive house? After all, even the most effective ventilation and cooling systems might struggle to counteract the glasshouse effect on a warm day.

This was the first issue that occurred to architect Tomas Gartner of Gale & Snowden when he started work on the project. "We had a building which was glazed on three sides, [and I had to] work it into a passive house without external shading, relying on just the ventilation strategy, and a client who was not prepared to put in flexible shading or anything like that," he says.

"At the starting point our first reaction was: 'no…can't do that'. It won't perform as a passive house like that. "Gale and Snowdon had been brought in to work on the detailing and planning for a design produced by another architect. The house hadn't been designed with the passive house standard in mind.

The plans did make the most of the scenery, however. "The views at that place are unbelievably outstanding," says Gartner. "So if you go there this is exactly what you want. You want to live in a glass box so that you can constantly see the sea on three sides." He started with some passive house modelling and this led to a partial redesign, which included taking out some of the glazed areas that were predominantly west-facing.

"The client didn't want any overhangs. They wanted to see the sea and they wanted to see the sky; they didn't want to obstruct their views. And at the same time it's in an exposed location where you can't have flexible external

Photos: Pete Cox Photography

shutters that easily because it's right on the Atlantic coast."

So what was his answer, then, to the likely overheating issue? "We actually applied design strategies which are more used in the Mediterranean for passive houses. We minimally insulated the floor construction and the rear wall construction, so that we passed building regulation requirements, and essentially then used the ground behind and underneath the building as a heat sink."

These parts of the building were only insulated to the minimum building regs spec, rather than to the passive house standard, so that heat inside will escape into the cool ground more easily, helping to prevent overheating in summer.

"Reducing the insulation levels will increase heat losses in summer and therefore cause a cooling effect," Gartner says. "This needs to be carefully balanced because it also increases heat losses in winter and any cold spots that could lead to condensation or discomfort of course have to be avoided, [and] for this a minimal amount of insulation has been allowed for."

Oyster Falls, which is 40 metres from the water's edge, has been built using traditional blockwork with steel frame supporting the ground floor. "The design is essentially a glass box on the ground floor, and more solid and restricted glazing on the first floor," Gartner says.

Gale & Snowden also specified some flexible external shutters and brise soleils to give the option of shade when it's needed, but the clients didn't want them. However the triple-glazed windows – supplied and fitted by passive house specialists Ecohaus Internorm – do their bit to moderate the overheating thanks to a low G value of between 35 and 40%, meaning they can let in light but not so much heat radiation.

Like Gartner, the contractor on the project, Eddie Acford of Point 6 Projects, also specialises in passive house builds (the name Point 6 derives from the passive house airtightness standard). "It was a really difficult project to build actually," he says of Oyster Falls —this was due to the topography of its site, the condition of the substrata, the location, design of the building and complex civil engineering.

Among the many civil engineering issues (which took six of the roughly 12-months of the build duration to resolve) was that the house is cut into a hillside that supports the main road between Braunton and the village of Croyde. "Extra measures had to be taken into consideration when building the foundations and the retaining wall to minimise risk of the road collapsing," ▶

Acford says. This included a five-metre retaining wall.

The changeable climate was another factor that had to be taken into account. "The environment is quite harsh, so we had to apply special finishes to all the windows, while all external fixes have to be stainless steel for example." All metal cladding to the windows and doors had to be marine grade. Strong glazing to the large sliding door was also needed to withstand the wind.

Inside, the house has 345 square metres of useable floor area, including four bedrooms, a boot room, a master bedroom with ensuite, an open plan ground floor area including kitchen, dining, and living space, with a separate utility room, larder, and storage. The heating duties are handled by a Genvex air source heat pump that supplies low temperature radiators.

The total cost of the project came in at £900,000. Gartner estimates the passive house element probably added 10% to the cost compared to a building regs compliant build up, but says the house was always going to cost more because of the size of the components needed, the overall quality of the build, and the exposed location. "A lot of the costs are essentially into the site itself, cutting into the ground, retaining the walls above the two storeys really," he says.

Like Gartner, Acford is impressed with the stunning location of the site, but as an experienced passive house contractor he is even more impressed by how the building manages to defy conventional passive house design with its strong glasshouse nature and its exposed location, with the indoor temperature still sitting as they do around 20-21C. "It's a testament to the design really, that a building in such a location with such an amount of glazing and such complexity can work in such a way. It is really something."

He acknowledges that the house does overheat occasionally, but that's more to do with the owner's aesthetic preferences. Tomas Gartner adds that, even with a Paul Novus MVHR system, the building needs a good old-fashioned daily manual ventilation strategy during the summer – opening the windows in the morning and in the evening – in order to keep things comfortable.

Unlike many low energy building approaches, passive houses are subject to overheating targets – with an obligation to ensure that the building doesn't exceed an average temperature of 25C for more than 10% of the year. According to Gartner the calculated figure for this building was just 1.5% – albeit based on calculations including a flexible shading device that the client declined to install. ▶

He concedes that if the house is unoccupied for a number of days the building will heat up inside but, at the same time, he fully understands Rupert and Charlotte's desire not to have any percentage of the windows cloaked by a solar shade or a shutter.

"There was never a discussion about that to say 'no, you can't have the views' or restrict window sizes or glazing because that is really what that location is about. So it was always about trying to make that work," he says.

Gartner, who has worked with Exeter City Council on passive housing, says the project was a new experience for him in terms of testing the ground heat sink effect, as well as studying passive house design strategies in hotter countries where overheating is a more common issue. The finished house is testament to the fact that passive house standards can be achieved with even the most challenging designs, locations and climate.

"We actually applied design strategies which are more used in the Mediterranean for passive houses"

"It is, for me, a real eye-opener that you can still achieve that with passive house, and that you have the flexibility in that design in that it suits a challenging brief like that," he says.

But what's the verdict from the clients? "We are very happy with the house and thoroughly ▶

(below, left to right) Knauf Rafterroll insulation packed between the TGI joists, forming the outer skin of the first floor walls; airtightness detailing at the wall-to-floor junction; construction of the retaining wall, which features an inner leaf of concrete block followed outside 100m of Jablite insulation and then fully tanked concrete retaining wall externally; (p37, bottom) The house features Internorm passive house certified triple-glazing throughout, including for individual window units and for the extensive glazed walls on the lower floor

enjoy it whatever the weather," says Rupert, adding that they particularly like "the view through the glass, the feeling of security from the elements and the ambience within the building due to the lack of heating systems."

SELECTED PROJECT DETAILS
Client: Rupert & Charlotte Hare
Architect/M&E engineer: Gale & Snowden
Structural engineer:
Barry Honeysett Consulting Structural & Civil Engineers
Project manager & main contractor: Point 6 Projects
Quantity surveyor: PWH Surveyors
Mechanical & electrical contractor: Boden M&E
Wall insulations:
Knauf & Celotex, via RGB Building Supplies
Roof insulations:
IKO Enertherm, via JGB Flat Roofing
Floor & retaining wall insulation: Jablite
Thermal breaks: Foamglas
Thermally broken wall ties: Ancon
Airtightness products:
Ecological Building Systems, via PYC Systems
Plastering: RL Cleary Plastering
Glazing, windows, doors: Ecohaus Internorm
Roof lights: DVS Ltd.
Oak cladding: JF Joinery
MVHR: Green Building Store
Lighting: Amos Lighting

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PROJECT OVERVIEW:

Building type: Detached two-storey 345 sqm house of steel, concrete and timber frame construction

Location: Croyde, North Devon

Completion date: October 2013

Budget: £900,000

Passive house certification: Not certified

Space heating demand (PHPP): 15 kWh/m^2

Heat load (PHPP): 11 W/m^2

Primary energy demand (PHPP): 116 kWh/m^2

Airtightness (at 50 Pascals): 0.53ACH

Energy performance certificate (EPC): N/A

Measured energy consumption: 9-20 kWh/m^2/yr

Thermal bridging: Mixture of cast insitu concrete, masonry and steelwork with the base of some of the walls being Foamglas. All the masonry ties are Ancon Teplo 2 low thermal conductivity cavity wall ties made from reinforced basalt fibre. Fully insulated reveals. Thermal bridges ambient: -0.014 W/mK / perimeter: 0.04 W/mK / floor slab: 0.04 W/mK

Ground floor: Raft foundation over strip footing followed above by ground bearing floor slab with perimeter insulation, 100mm Jablite insulation, timber floating floor. U value: 0.30 W/m^{2}K

Walls
First floor, on three-sides facing the sea: 15mm wet plaster inside forming airtightness layer, followed outside by 140mm dense block, followed outside by 300mm Knauf Rafter Roll packed between TGI joists, external weather board and oak rainscreen cladding.

First floor, facing the street, where building connects to retaining wall: 15mm wet plaster inside forming airtightness layer, followed outside by 100mm dense blockwork, 200mm Celotex PIR insulation, 50mm cavity, 150mm natural stone walling. U Values 0.10 - 0.15 W/m^{2}K

Retaining wall (to rear of ground floor): Plaster finish internally forming airtightness layer, 100mm concrete block, 100mm of Jablite insulation, full tanked concrete retaining wall externally. U-value (approx): 0.30 W/m^{2}K

Roof: 18mm T&G plywood followed above by vapour control membrane, 260mm high performance IKO Enertherm insulation, flat roofing IKO / ICO-PAL membrane. U-value: 0.10 W/m^{2}K

Glazing (inc glazed walls): Internorm Edition Passiv triple-glazed PHI Certified timber /aluminium glazing. Powder coat finish for extreme conditions Overall U-value: 0.82 W/m^{2}K

Roof lights: Lamilux FE 3° triple-glazed roof lights. Manufacturer declared U-value: 0.9 W/m^{2}K

Ventilation: Paul Novus 450 MVHR with 2kW post heater. PHI certified 89% heat recovery efficiency.

Heating: Genvex Vanvex R85 air source heat pump supplying radiators, plus post heater in ventilation ducts and standalone wood burning stove.

Green materials: Structural timber and cladding is FSC certified, untreated durable local hardwood cladding, natural stone from local sources, FSC certified timber framed windows and doors, timber furniture from PEFC certified sources, VOC-free and edible paints

East London passive school

promotes active learning

Photos: Paul Riddle

The head teachers of an East London school put their interest in sustainable building into practice by adding a new passive house extension — and the results already seem to be paying off for pupils.

Words: Ekaterina Tikhoniouk

The Stebon Primary School extension, located in the London Borough of Tower Hamlets, is set to be one of London's first certified passive house school buildings. Situated on a rectangular site surrounded by apartment blocks, the new two-storey classroom block is linked by a glazed corridor to the original 1950s brick and concrete-panelled school building.

The main motivation behind the school extension was to enable the school to take in more students. The school's two headteachers, husband and wife team Jeremy Iver and Jo Franklin, also manage nearby Bygrove Primary School and had previously pushed for Bygrove to be re-furbished to Breeam standards. They continue to be vocal about their interest in sustainable buildings. "For us both, sustainability is really, really important and we wanted our build in Stebon to reflect what we feel," Iver says. "And that's what we told the architects when they came around to talk to us about the extension."

Iver and Franklin's passion for sustainability gave the appointed architects Rivington Street Studio and main contractor Bouygues UK the idea of proposing a passive building. Rivington Street Studio director David Tucker says: "We didn't want to go for Breeam, as there are certain ▶

aspects of Breeam that I see as being extra costs, just for getting credits." So he advised the school to go for the passive house standard instead.

The headteachers were eager to get on board. Iver says: "David Tucker came back to us and said, 'there's this thing called passive house', and we then went to see a few building sites together, including a finished school. And we were completely convinced."

Bouygues UK had no prior experience of building to the standard, but was eager to learn and to add a passive house string to its bow. The next step was getting the local authority on board. "To their credit, the local authority went with it as well," Iver says. "It ended up being more expensive than planned, and so we had to make do without certain things that we had wanted so that we could afford the passive house build. But it wasn't significantly more, and still within the budget that they had set, so the authority took a leap of faith."

According to architect David Tucker, another key priority for the parents, school and local authority was getting a building without defects. He says that apart from sustainability, all three groups saw meeting the passive house standard as way to ensure the extension was built properly.

Rivington Street Studio had worked on a number of schools across London, but had never taken on a passive house project before, so leading architectural practice Architype — who have built several schools to the standard — came on board as advisors.

But it still proved to be a sharp learning curve for Rivington Street Studio. Tucker says: "We had to completely rethink how we construct buildings. We took the decision to simplify the building's form as much as possible, to make it less complicated to build."

Each classroom has a small radiator, fuelled by a central condensing gas boiler, for any space heating needs in winter. The build emphasised green materials too — the timber frame is insulated with cellulose (recycled newspaper) and features a Fermacell board lining to most internal partitions.

Anecdotally, the teachers believe there has been an improvement in the behaviour of the six classes that moved into the extension in January 2015. Variously, teachers have reported calmer classes, better acoustics (which reduces the need to shout), and less sneezing and allergies.

"The old part of the school isn't necessarily a bad building," Iver says. "It has big classrooms, big by modern standards certainly, and lots of daylight. However, the old building is both colder in winter and warmer in summer because of the great south-facing windows. In summer it can get fiercely hot." He admits, though, that in the passive house extension, classrooms can also get too hot during the summer if the teachers forget to open the windows in the evenings to allow for night cooling.

Tucker would like to set up data loggers in the classrooms to monitor the building's performance. "That is the next step, it would be great to get that data. We hope to see that the building is performing well in terms of air quality, temperature and lighting levels."

Iver says other data is already suggestive of the building's performance. Comparing the autumn of 2014 with the summer of 2015, attendance rose higher (1.8% versus less than 1%) over the course of the year in the six classes that moved into the passive house extension in January.

Iver also says 88% of year six pupils achieved a combined level four achievement in reading, writing, maths and grammar in the old building in

"It uses somewhere between 10% and 30% of the energy of a conventional new build, which converts back into money in the school's resources"

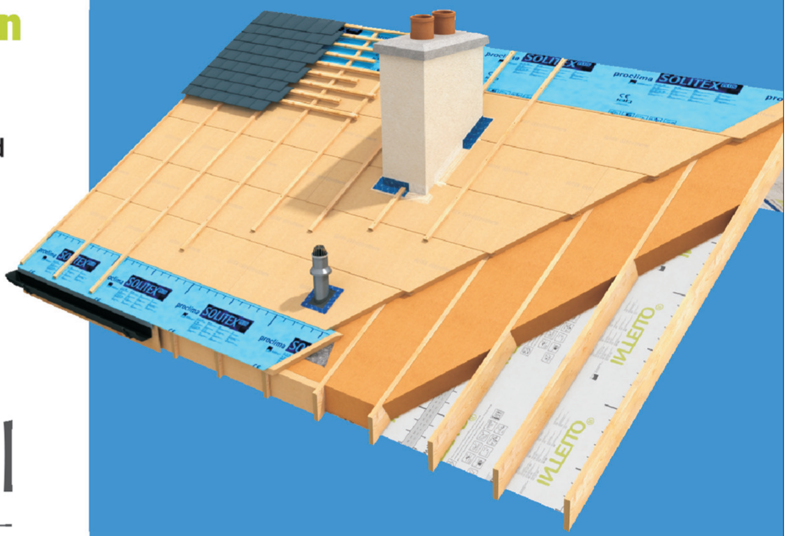
Iver adds that the contractor, Bouygues, put lots of effort into making sure the building was completed before the beginning of the January 2015 term, and handed over a well-built and fully-finished extension.

The new timber-frame building – with a structure by Irish passive house specialist Cygnum, a veteran of several Architype-designed passive projects, including other schools – is joined to the original school by a glazed corridor, but an external door was used to thermally separate the new and old sections. "The extension is basically an airtight sealed box," says Tucker. During winter, the extension uses a Swegon mechanical ventilation heat recovery (MVHR) unit to deliver preheated fresh air. In summer, the building uses a natural ventilation strategy, and cooling is achieved by opening the school's windows at night.

2014, but this shot up to 95% the following year when the year sixes moved to the new building. "That's certainly a significant increase over the space of one year," he says.

Of course you can question whether this data is scientific — the sample size is small and there are lots of other factors that could influence the figures apart from the change of building. But it does suggest that a robust scientific survey of the effects of passive house schools on attendance and academic achievement is warranted.

But the new extension has still had some teething issues, Iver says. "I've heard that passive house buildings can be tricky to use correctly at first, and we have found that." He says the main issue is with staff forgetting to open the windows at night to purge heat, which can lead to overheating ▶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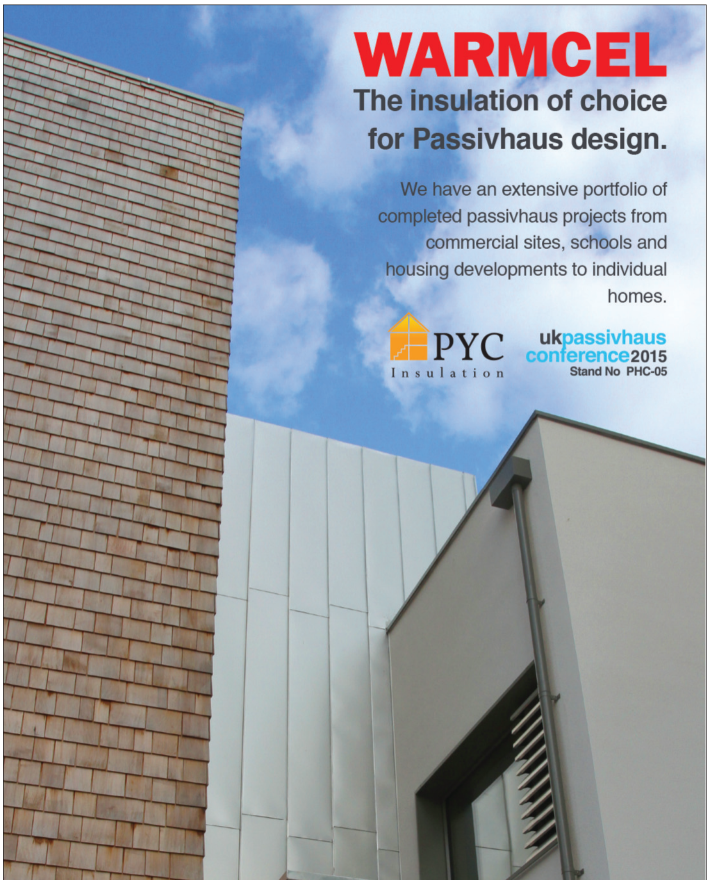


Wilkinson Primary School

(above) the new two-storey classroom block is linked by a glazed corridor to the original 1950s brick and concrete-panelled school building; (p41, top to bottom) timber-frame modules from Irish manufacturer Cygnum waiting to be assembled on site; the timber frame roof prior to installation of the triple-glazing; the structure before insulation with Warmcel 500 cellulose; airtightness detailing, with tapes from Pro Clima and Siga, around the windows; membranes brought under the Gutmann aluminium sills for maximum airtightness

inside the following day. "Also, each room has a very small radiator and it's been hard to break the habit of having it on," he says.

"We definitely haven't gotten a 100% handle on the ventilation yet. I'm not sure if it's working in exactly the way it should yet and whether that's because we haven't figured it out yet. Our problems are with being too hot rather than anything else."

But overall the headteachers are very happy with the passive house extension. "It has indeed exceeded all of our expectations," Iver says.

"The building is beautiful. And it uses somewhere between 10% and 30% of the energy of a conventional new build, which converts back into money in the school's resources. The children are incredibly proud of the new extension and love showing it to visitors. It means a lot to them."

SELECTED PROJECT DETAILS
Architect: Rivington Street Studio
Client: London Borough of Tower Hamlets
Main contractor: Bouygues UK
Passive house consultant: Architype
Passive house assessment: Warm
Timber frame & superstructure engineering: Cygnum
M&E consultant: BDP
Structural engineers: Barrett Mahony Consulting Engineers (substructure and remodelling works)
Blown cellulose insulation: Warmcel, via PYC Insulation
Under slab insulation: Knauf
Windows & doors: Pacegrade
Airtightness products: Pro Clima / Siga
Sheathing boards: Hunton
OSB: Smartply
Building boards: Fermacell
Roofing: Bauder
Solar PV panels: Risen
MVHR: Swegon
Condensing boiler: Remeha
Bricks: Ibstock

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PROJECT OVERVIEW:

Building type: 1,250 sqm new two-storey classroom extension built to the passive house standard as part of the expansion and refurbishment of an existing primary school. Refurb included internal remodelling and upgrade of parts of the building fabric to Part L standard.

Location: Stebon Primary School, Poplar, London Borough of Tower Hamlets

Budget: undisclosed

Space heating demand (PHPP): 10 kWh/m²/yr

Heat load (PHPP): 8.1 W/m²

Primary energy demand (PHPP): 119 kWh/m²/yr

Passive house certification: Pending

Energy performance certificate (EPC): A 23

Measured energy consumption: Not yet available

Airtightness (at 50 Pascals): 0.52 air changes per hour

Walls: External larch cladding or brick on 50mm ventilated cavity, followed inside by 12mm Hunton Bitroc sheathing boards, 339mm engineered timber frame by Cygnum fully filled with Warmcel 500 cellulose insulation, 18mm OSB board forming airtightness layer, 38mm services zone, various dry linings. U-value: 0.13 W/m²K

Roof: Bauder Total Roof System (bituminous membrane) externally, followed underneath by 18mm Spruce WBP ply sheathing on timber firrings to create a 200mm ventilation zone (reduced to 100mm at gutter locations), 12mm Timbervent with windtight vapour permeable breather membrane to full extent of roof, 406mm engineered I-Beam by Cygnum fully filled with Warmcel 500 cellulose insulation, 18mm OSB board forming airtightness layer, plasterboard fire lining. U-value: 0.129 W/m²K

Ground floor: Floor finished on levelling screed, followed beneath by 300mm thick ground slab, Visqueen High Performance DPM, 200mm Knauf Polyfoam Eco Floorboard Extra insulation. U-value: 0.127 W/m²K

Windows: Thermally broken triple-glazed units, assembled by Pacegrade using Gutmann aluminium profiles. Overall U-value of 0.60 W/m²K

Ventilation/heating system: Swegon RX Gold 35 MVHR unit. Passive House Institute certified heat recovery efficiency: 84%

Hot water: Remeha 65 kW high efficiency condensing gas boiler

Green materials: Engineered timber frame, blown cellulose insulation, treated larch cladding, Fermacell linings to internal partitions

Solar Electricity: 12 Risen SYP250P 250W solar photovoltaic panels with average annual output of 3kW

Longford self-build

goes certified passive on a budget

Photos: Kelvin Gillmor Photography

Three years ago quantity surveyor Ross Cremin set out from scratch with the goal of self-building a passive house on a site in rural County Longford. Here he tells the story of his project and offers advice for others thinking of building their own passive house.

Words: Ross Cremin

Once upon a time there was a couple living in the heart of Dublin City, then two became three and three became four so it was time for this family to get out of their small city house and go on an adventure: relocating to the countryside and building a house.

It was 2012, the depths of the recession, and my wife and I were both self-employed with a house in negative equity — not the bank's favourite customers. But we decided to move from Dublin to the drumlin country around the Longford-Cavan border, where I had bought a derelict cottage on one acre fifteen years previously (never thinking I'd be raising a family there).

We wanted a house that would be bright, healthy, draught free, warm in winter and with low running costs. We wanted it to be future proofed against changes in building regulations and rising energy costs. Great indoor air quality would be a bonus too.

We begged, borrowed and stopped short of stealing and had a budget of €150,000 to start with. The dream was to build a certified passive house combined with separate office/guest accommodation, plus a shed. I did say dream. So could it be done, and how did we get on?

Being a quantity surveyor, I had a good idea what building a passive house would involve, although I had never worked on one directly. But I was very curious, and having studied further it seemed like the obvious road to take. But would it cost more, and how much more? My training and work taught me that any additional costs must provide an economic benefit — would a passive house achieve this?

We employed an architect (the ever patient and meticulous Sarah Cremin from CAST Architecture, who joined us on the steep learning curve) a passive house consultant (Archie O'Donnell of Integrated Energy) and a project manager. A word of advice for anyone tempted to tread similar water: hire professionals, ideally with passive house experience and ideally from project conception. It may feel like a big overhead at the time, but it pays off in the long term. Having a project manager on board was a great success, one of my better decisions. He ultimately brought the house up to a weather-tight shell and I took over from there.

We built the timber frame on site ourselves. But the build took us two years, partly due to our budget deficit, which we saved as we went along. There were plenty of stressful moments — a baby being born, two businesses to run, getting to grips with the many decisions a new

build brings, not to mention the passive element. It felt like I was endlessly researching the details, components and finishes of the house, bordering on the obsessive. My wife began to think I was suffering from passive compulsive disorder, but I told her she was just being passive aggressive. You can see how the two years were a little stressful.

The finished house is of a relatively simple design, or as an architect might say, a "modern interpretation of the vernacular". Most of the rooms have southerly aspects and so are bright and warm. This design facilitated meeting the passive house standard, and luckily our orientation also faced south and the best view. The only major change we had to make to the design was to reduce the windows slightly on the north elevation. It's not a big house by any means at 150 square metres, but we've made maximum use of the space.

The timber frame sits on a raft foundation and has a plastered blockwork rain screen. We chose timber frame as we felt it was simplest to make airtight and minimise thermal bridging. The entire outer envelope (walls and roof) is clad in 50mm PIR board to cut cold bridges. Continuous insulation to the entire thermal envelope of the house is the most effective way to reduce heat loss. The 220mm timber frame is fully filled with mineral wool and the service cavity inside is also filled with mineral wool — this is the same for the walls and roof.

There's nothing unusual about the build except maybe that we built the timber frame on site. We used corrugated iron for the roofing, which saved a considerable amount of money, but we also like the look of it. The gutters and down pipes are all pressed out of the same material. We used birch plywood extensively in the interior — window liners, stairs, kitchen, flooring and panels to some walls. The finished floor on the ground floor is power floated concrete with a dry shake floor hardener sprinkled in at 5kg per square metre, and then sealed. It's a poor man's take on polished concrete.

We found the design of the heating system the most challenging part of the build, with so many options and systems available. It seemed that there was something new coming along every week. My project manager got frustrated with my indecision as I kept changing my mind.

The core issue that confused us most was the concept that, with a passive house, there is no need for a conventional heating system. Could we build a house in Ireland without central heating? Everyone has their own opinion and everyone is an expert. I was advised by many people to put radiators or underfloor heating throughout the house "just in case", but in my mind this defeated the whole purpose of a passive house. I had read many stories in this magazine of homeowners putting in underfloor heating "just in case", and then never using it. Also, is it ingrained in our Irish psyche to feel the need to sit on radiators or at least be able to touch and see them?

In the end, after many meetings, trades shows, hours spent online, house visits, consultations, and articles read in this magazine, we decided to ▸

(above) birch plywood was used extensively in the interior for the stairs, kitchen and some walls; (below) low-energy features of the build include, from left, Siga Majpell membrane for airtightness in the roof, 50 mm Quinntherm PIR insulation under the roof battens, with Balaroid breather membrane installed over, and then counter battened; (opposite, right) various stages of construction showing the inner leaf of the rising wall, which consists of low thermal conductivity Quinn Lite blocks, and erection of the timber frame, which was built on site and insulated externally with Quinntherm

trust in PHPP (the passive house design software) and the passive house design process. Keeping it simple is never more important than when building a passive house.

We now have a wood burning stove that heats our large open plan ground floor and also provides all our hot water needs during the winter. Most of the stove's energy (5.4kW) goes to heating the water, with only 2.6kW used for space heating. The stove has been phenomenal. Its 230 kg of German engineering is quite imposing in the living room. It is room air sealed with a DIBT certificate (German Institute of Building Technology). It's a pleasure to use and lighting it is one of my favourite parts of a winter day. We only had to clean it out once during all of last winter, and even then there was only a quarter bucket of ash.

The heating system was substantially cheaper than for a conventional build, with the stove being the most expensive component. There are no touch screen control panels, smart phone apps or automation sequences. We saved the bells and whistles for the home entertainment system.

Many people, including some of the professionals, were surprised by the "risk" we took by going down this minimal route. But there is simply no need for central heating in a passive house. I really wish we had known this from the outset — it would have simplified the design process and saved a lot of time and hassle. To people embarking on a passive build, my advice is to trust the process and PHPP. You're not going to be cold.

We also chose to avoid any "green bling", as it seems to be referred to these days. We have no heat pumps, solar panels or rainwater harvesting. I feel that by building to the passive standard, we have reduced our energy demand to such a low level that we're already making a much smaller impact on the environment. We use wood sourced locally to produce hot water and the little heat that we need in winter. Summer hot water is produced by the immersion heater which comes on for one hour each day. The sums for solar thermal panels didn't balance for me financially.

We're in the house just over a year and quite honestly it has been a pleasure. At Christmas

we had no cold room to keep the turkey in for St Stephens Day so we had to put it out in the car. The MVHR (mechanical ventilation with heat recovery) is also very impressive – we're all sleeping brilliantly and if the lamb chops burn then we can quickly get rid of the smell.

To put that in context, a comparison to the Bruce Shaw Partnership's 2015 handbook is illuminating. The book doesn't include costs for a detached self-build house, but we can get a rough idea by comparing to the average cost range for an estate house of circa 100 sqm.

"The house's acoustics are also excellent — we're always startled when someone knocks on the door as we never hear cars arriving."

We've put an extract vent in the hot press and clothes dry very quickly. The house's acoustics are also excellent — we're always startled when someone knocks on the door as we never hear cars arriving. We experienced a little overheating in August when temperatures inside reached 24 or 25C, but this was relieved by opening windows. We are planning to put sliding shutters over the windows for shading eventually, but it keeps getting put on the long finger.

In the end, we built the house for €187,000. This excludes the architect's fee and the sewage treatment works, but includes Vat. Once Vat is deducted, the cost comes down to circa €165,000, which works out at €1030 per sqm.

The book lists a cost range – excluding Vat and professional fees – of €1050-1300 per sqm.

The windows and mechanical ventilation were substantially more expensive than their non-passive certified competitors. I struggled with this as the financial payback was questionable. I had no difficulty with the extra insulation and airtightness required, as the benefits were obvious. But the quality of the windows and MHRV are both superb, and both of these components have come down in price in the few short years since we have built our house.

This project is still a work in progress. As I write this article, we have started fitting out ▶

the office/guest house, which we have built to the exact same standard. When doing the groundworks we fitted an insulated pipe to deliver hot water from the main house, and we've installed a de-centralised Lunos MVHR unit from Partel in Galway here too.

Has it been a "happily ever after" for this gang of four and was it worth the extra cost? Yes and yes. We are living in an amazingly efficient, comfortable home. So far so good as we start into our second autumn, which beckons blackberry picking season around here.

You can read more about Ross Cremin's passive house self-build on his blog, www.mollyglass2012.tumblr.com

SELECTED PROJECT DETAILS
Client: Ross Cremin
Architect: Cast Architecture
Passive house consultant: Archie O'Donnell
Passive house certifier: Mosart
Roofing: CPF Profiles Ltd
Electrical contractor: Smartheat
Main contractor / timber frame: Self-build
Mechanical engineer: Sean Magee
Civil/structural engineer: AFM Consulting Engineers
Project manager: Edward Rooney
Mineral wool insulation: Isover
PIR insulation: Quinn
Windows: True Windows
Insulated foundations: Kingspan
Airtightness products: Siga
MVHR: Beam
Decentralised MVHR to guesthouse/office: Partel
Stove: Spartherm
Flue: Poujoulat

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PROJECT OVERVIEW:

Building type: 160 sqm two-storey timber frame detached house

Location: Co Longford, Ireland

Completion date: April, 2014

Budget: €187,000 (incl of Vat & PH certification, excl of architects' fee and sewage works)

Passive house certification: Certified

Space heating demand (PHPP): 15 kWh/m²/yr

Heat load (PHPP): 10 W/m²

Primary energy demand (PHPP): 101 kWh/m²/yr

Airtightness: 0.63 ACH at 50 Pa

BER: N/A yet

Thermal bridging: Entire timber-frame envelope insulated externally to cut thermal bridging

Ground floor: 300 mm concrete slab insulated with 300mm Aerobord platinum EPS 100. U-value: 0.112 W/m²K

Walls: Plasterboard internally, followed outside by 100mm service cavity, 220 mm timber stud insulated with high density Isover Metac, 50 mm Quinntherm PIR outside the timber studs, ventilated studs, external blockwork rain screen. U-value = 0.102 W/m²K

Roof: Corrugated metal roofing externally on counter battens, on Balaroid breather felt, on battens, on 50 mm Quinntherm PIR insulation, on OSB, on 220 mm timber rafter insulated with high density Isover Metac mineral wool, on Siga Majepall membrane and tapes with an internal service cavity of 100 mm also insulated with Metac. U-value = 0.103 W/m²K

Windows: Gutmann Mira Therm 08 — PH78 PHI certified timber aluclad windows with insulated timber frames. Overall U-value = 0.80 W/m²K.

Planilux glazing with low-e coatings and argon fill. Ug-value = 0.7 W/m²K. G-value = 62 %.

Front door: Moralt Ferro Passiv PHI certified insulated timber door. Overall U-value = 0.8 W/m²K

Roof windows: 4 x Keylite Futuretherm triple-glazed roof windows. Overall U-value: 1.0W/m²k

Heating system: 8 kW Spartherm Ambiente A4 H20 room sealed wood burning stove with integrated heat exchanger to heat 300L buffer tank and three radiators (one in each bathroom). 2.6 kW to room, 5.4 kWh to tank. 88% efficiency. Certified airtight by DIBT.

Poujoulat flue system with external air intake in insulated sleeve to prevent condensation and damper to close air duct when not in use.

Ventilation: Dantherm HCH 8 heat recovery ventilation system installed within the thermal envelope, brings in fresh air to all living rooms and extract from all wet rooms. Passive House Institute certified to have heat recovery rate of 83%


Certified
Passive House

NEW COASTAL ICF HOME

goes passive at low costs

This house on the coast of County Waterford is built from an insulated concrete formwork shell that delivers an inherently warm and airtight construction, and easily exceeds passive house targets.

Words: John Hearne

The sequence of houses in which John Carney has lived over the last thirty-five years, neatly encapsulates how house building has progressed over that time. He's gone from a two-room cottage to a passive standard two-storey, by way of a 1990s low-energy house.

"The cottage had no running water," says Carney, "two light-bulbs and one power point…I added a bathroom and a bedroom, and put in a septic tank, but then in 1990 we decided to build a new low-energy house and moved in around the time Mary Robinson got elected. We lived there for 25 years, and the house functioned very well, but as I became more aware of passive house, airtightness and all these things, it was almost as if I could feel the breeze more in the house."

A quantity surveyor by profession, Carney lectures in construction management and engineering at Waterford Institute of Technology. In addition, he continues to work in the construction industry, preparing tenders for contractors and looking after the financial administration of projects. His career-long interest in sustainability brought him to conferences all over Ireland and Europe, keeping abreast of developments and making sure his students were aware of what was happening at the cutting edge of construction. He also had one eye on the day when he would put all he had learned into practice, and build his own passive house. He says: "I always thought if I was going to build, it would be great to do something like that."

The house, which overlooks the Atlantic on the Waterford coast, has the appearance of a cottage from the front, but is in fact an inverted two-storey house. The living areas are located on the first floor with the bedrooms on the lower floor, which slots neatly into the sloping site.

Carney was inspired to reduce the size of the house by a piece in this magazine by Irish Green Building Council director Pat Barry which queried whether a large passive house could be considered sustainable.

Jeff O'Toole of Passive House Solutions is a specialist in low energy building and design, and a former pupil of Carney's. Retained as a consultant on the build, one of his first jobs was to take the architect's design and adapt it to passive house specifications.

"The original design was a bigger house with a lot of tricky detail on it," he says. "There was going to be a carport on the lower ground floor, and a garage, but once I started looking at it, I realised there were loads of areas where it was going to be difficult to get thermal bridge-free construction or achieve the airtightness."

This wasn't a complete redesign, he's keen to point out. The architect's basic orientation and layout largely conformed to passive principles. O'Toole simplified things, putting the design through the passive house design package PHPP in order to ensure that the building fabric delivered, and to help make the house more buildable.

Carney and O'Toole spent a lot of time assessing the various building methods before settling on insulated concrete formwork, or ICF.

Photos: John Roche

"ICF came into its own on the site," says O'Toole. "Because it was split level, it had to have a retaining wall along the back, and if it was going to be any other construction type, timber frame or block wall, a concrete retaining wall would have had to go in there. Instead, John found a way of using the ICF wall as his retaining wall as well as the primary structure for his house."

The ICF system was designed and built in Naas by Amvic Ireland. Pat Martin of Amvic says that one of the key advantages of ICF is that its advertised U-values are intrinsic to the system. "We can't take short-cuts like not fitting insulation properly, nor can we mess with the quality of the product by not having the correct densities or properly filled moulds, otherwise the concrete would blow it apart. So once the wall is standing, it will perform."

The standard system delivers a U value of ▶

John Carney has been monitoring his new passive house & his previous two houses. "The cottage gets down to 7C. The middle house is around 12C and the passive house is about 17C – over a period of time when all the houses were unoccupied and unheated."

0.22. To get that down to the required U-value for this particular passive house of 0.15, an additional layer of insulation was added to the outside of the structure. “We used our own moulded 100mm [EPS] panel with stepped sides,” says Martin, “which means it overlaps to all its neighbours on all four sides so there’s no risk of cold bridging; they all fit perfectly against each other on the wall.”

Jeff O’Toole says that the system was “a dream” to work with. “The consistency of the insulation is the thing. It was completely continuous, plus it was very easy to add an extra layer of insulation onto the outside of it to get the U-values down.”

ICF came with one other key advantage. Because of the density of the concrete mix used, the wall was naturally airtight. The blower door test result, at 0.31 air changes per hour, lies well inside the passive threshold.

All internal partitions are blockwork, in part to support the precast concrete floor slabs and in part to provide thermal mass. At foundation level, the ICF ties in with the insulated foundations, removing any thermal bridging issues here.

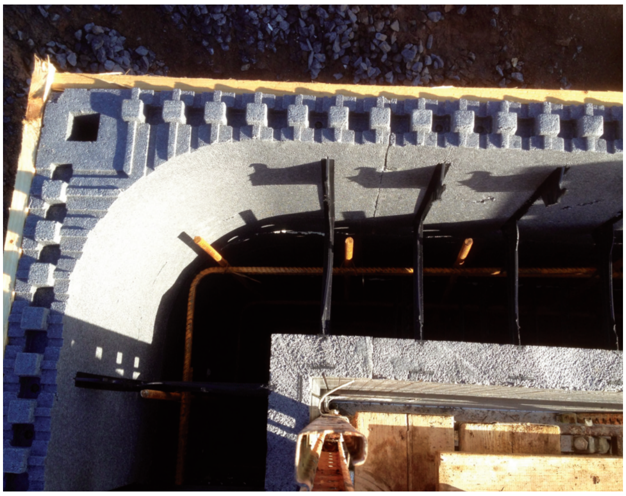
John Carney decided not to seek passive house certification, though the house operates well inside all of the passive targets. According to Deap, the house gets an A3 rating, and complies with everything but the minimum renewable energy contribution of 10kWh/m^2/yr. (This figure is taken from the technical guidance document associated with Part L of the Irish building regs rather than the regulation itself, which only states that a “reasonable proportion” of a dwelling’s energy demand be met by renewables. Thus there is a strong case that a passive house can produce less than 10kWh/m^2/yr and still comply with the law, on the proviso that a “reasonable proportion” is being generated.

Jeff O’Toole says: “John put in a 300 litre cylinder with Kingspan [solar thermal] tubes on the roof, which came in a 8kW/m^2/yr, which is more than enough hot water for what John needs. There are only two people living in the house, so to meet the renewable requirement [in the technical guidance to Part L], they would have had to over-specify the solar thermal.”

John Carney has been monitoring his new passive house, but also the houses in which he lived previously — both of which he still owns. “The cottage is goose pimple-cold, especially when there’s no heat on. The temperature gets down to 7C inside in the house. The middle house, the one built in 1990, is around 12C and the passive house is about 17C, and that’s over a period of time when all the houses were unoccupied and unheated.”

Carney also kept close tabs on the budget throughout the project, which ran from October 2012 to November 2013. Total spend per square metre was €1,225 inclusive of Vat, and that includes everything, from local authority contributions to the tarmac driveway, entrance gates, dry-stone walls, landscaping, rainwater harvesting and the sewerage treatment facility.

“The house itself was a wonderful experiment,” says John Carney. “Someone said to me, it was an expensive experiment but it wasn’t expensive, it was a very worthwhile exercise. I had the site, I had the planning permission, I had the water supply right onsite, I had a little bit of expertise in construction, and I got tremendous mileage out of it from a teaching point of view.”



(top) The Kingspan Aerobord foundation system consists of three layers of EPS 100 with a 400mm deep ring beam to carry ICF walls; (above, left) Neopor graphite EPS forms the inner and outer layers of the ICF walls, with concrete then poured in between; (above, right) to further lower the U-value of the walls to meet passive house standards, an extra 100mm of Neopor was fixed externally; (below, left) Siga Majpell membrane in the roof for airtightness; (below, right) rigid ducting for the Pro Air 600 mechanical heat recovery ventilation system

SELECTED PROJECT DETAILS
Client, project manager & QS: John Carney
M&E engineer: Dick Power
Passive house & airtightness consultant: Passive House Builders
MVHR: ProAir
Electrical contractor: Chris Orpen
Insulated concrete formwork: Amvic Ireland
Roof insulation: Knauf
Insulated foundation system: Kingspan Aerobord
Airtightness products: Siga
Windows and doors: Munster Joinery
External rendering: DMC Plastering
Fit out & furniture: DFL Joinery
Groundworks, drainage & substructure: Power Ground Works

PROJECT OVERVIEW:

Building type: 245 square metre detached split level two storey ICF house

Location: Dunmore East, Co Waterford

Completion date: May 2015

Budget: €300,000 total cost excluding site purchase, but including Vat, council levies, self-build insurance & external works.

Passive house certification: Uncertified

Space heating demand (PHPP): 8 kWh/m²/yr

Heat load (PHPP): 10 W/m²

Primary energy demand (PHPP): 109 kWh/m²/yr

Airtightness: 0.33 ACH at 50 Pa or 0.4 m³/m²/hr at 50 Pa

Energy performance coefficient (EPC): 0.37

Carbon performance coefficient (CPC): 0.385

BER: A3

Thermal bridging: Kingspan Aerobord foundation system, Amvic insulated concrete formwork. All junctions as per Amvic ICF thermal bridge-free details, thermally broken window frames, Calculated Y Value: 0.001 W/mK

Ground floor: Kingspan Aerobord foundation system consisting of three layers of EPS 100 with 400mm deep ring beam to carry ICF. U-Value: 0.10 W/m²K

Walls: Weber external render on 100mm Neopor graphite EPS insulation mechanically fixed to Amvic ICF system, comprising 63mm Neopor graphite EPS, 150mm concrete core (200mm core on retaining walls), 63mm Neopor EPS, finished inside with 15mm Gypsum Rigidur boards on 15mm metal top hat. U-value: 0.13 W/m²K

Roof: Tegral Thrutone fibre cement slates externally on 50x35 battens/counter battens, followed underneath by breathable bitumen impregnated sarking board, 500mm timber attic truss fully filled with Knauf Earthwool Insulation, 15mm taped & sealed OSB, 50mm uninsulated service cavity, 12.5mm plasterboard ceiling. U-value: 0.10 W/m²K

Windows: Munster Joinery triple-glazed argon filled Passiv aluclad windows. Overall U-value: 0.79 W/m²K

Heating: One electric storage heater set on night rate electricity in the centre of the house. Dimplex electric fire plus electric panel heaters in the bedrooms. Electric Devi matts in the bathrooms. 30 Kingspan Thermomax solar vacuum tubes supplying separate 300 litre domestic hot water tank.

Ventilation: Pro Air PA600 mechanical ventilation with heat recovery system with rigid ducting

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The UK's greenest ever retrofit — 6 years on

This pioneering upgrade project, completed in 2009, turned a Victorian redbrick in Birmingham into one of the UK's greenest homes. Along with a much wider ecological agenda, the house employed fabric first principles of insulation and airtightness, and met passive house design targets at a time when the standard was still in its infancy in the UK.

Words: Lenny Antonelli

The highly ambitious eco-retrofit of an 1840's house in Birmingham — completed six years ago — employed a swathe of natural and ecological materials, cut the house's energy consumption down to passive house levels, and now employs only renewable energy to heat and power it.

The house was designed by architect John Christophers of Associated Architects — working here in a personal capacity — for his young family, after they bought the house with the intention of retrofitting. Dubbed the Zero Carbon House, it was the first retrofit in the country to reach level six on the Code for Sustainable Homes. Before the build Christophers considered aiming for the passive house standard, but there was no passive retrofit standard at the time.

The Code for Sustainable Homes had just been launched as the UK's primary green building rating system, and Christophers was keen to develop a project that could be taken into the mainstream and replicated. So he chose to aim for code level six, which ruled out the use of fossil fuels, and imposed a slew of other strict eco-standards of water consumption, materials and biodiversity.

But the house still has passive principles at its heart — with its emphasis on airtightness, thermal bridge free design, and lots of insulation. Christophers wrapped most of the external walls with a Neopor EPS system from Sto. To minimise thermal bridging, he insisted this be installed without mechanical fixings, so the team used an epoxy adhesive instead.

Christophers took a different approach with the front elevation, insulating it internally with 350mm of Warmcel — fitted into new timber studwork — to preserve the house's historic facade. "We've got lovely old brickwork and stone facings and so forth which we didn't want to lose," he says. To deal with any potential condensation behind the internal insulation, where the temperature drop could create a dew point for water vapour to condense to liquid, there is a drained cavity here.

The original roof was mostly retained, but the old ceiling joists were taken out. The team put in a framework of new timbers hanging from the original rafters, creating a void of 450mm that is filled with Warmcel and lined below with a Pro Clima Intello Plus membrane for airtightness and vapour control.

A new extension has roughly doubled the size of the house, adding a second floor and extending onto vacant ground beside the house. The new walls were constructed with Sumatec Earth Blocks, manufactured from hydraulically compressed clay. Christophers previously developed an interest in earth-based building materials while working on an eco house in Worcester, which had cob walls made from earth dug up on site.

Sumatec blocks, he says, are naturally able to regulate humidity by absorbing water vapour and releasing it, while they also provide thermal mass that helps to buffer indoor temperatures. The emphasis on earth-based materials continues to the ground floor, which is finished throughout the house with rammed earth formed from clay dug up on site, then finished with linseed oil and beeswax. "It's as hard as any sedimentary rock after a few years," says Christophers. In the old part of the house, the existing floor joists were treated and insulated with Warmcel and made airtight with an Intello Plus membrane (there is a ventilated cellar beneath).

All of the external walls are finished inside with a lime plaster that also serves as an airtightness layer. The final airtightness test produced a result of 0.97 $m^3/hr/m^2$ — or 0.57 air changes per hour in passive house terms, just inside the new build passive standard, and quite an astonishing result for a time when there were few references for passive retrofit. (By contrast a blower door test taken before the retrofit produced a result of 28 $m^3/h^3/m^2$, almost thirty times leakier).

Christophers and his team used a small blower door machine and smoke pencils continuously during the build, to ensure there would be no major surprises come the final test. "I suppose what I've learned is that to do airtightness…you have to be completely obsessive about detail," he says. He praises his contractor, Speller Metcalfe, who he says had an appetite for "not being daunted by things" (the builders also recycled almost 100% of construction waste during the project).

In terms of heating — and besides internal gains from occupants and electrical appliances — the house has an eight square metre solar thermal array which feeds an 850 litre thermal store, which delivers domestic hot water and services one towel radiator. In very cold weather, the family can also light a wood burning stove, which delivers 20% of its heat for direct space heating and 80% to the cylinder.

"We've never needed to light that stove past about the eighth of February," Christophers says. All of the wood used for the stove to date has come from an ash tree in the garden, which was cut back during the build as a condition of planning permission (the tree's leaves also provides shade in summer to the south-west facade).

Mechanical ventilation with heat recovery (MVHR) provides fresh pre-heated air in winter, but Christophers says he turns off the MVHR in summer to save electricity and rely on natural ventilation. Secure vents are opened at night to purge the house of heat, while high-level windows encourage a natural stack effect that draws warm stale air up and out of the building. In the spring and autumn, Christophers can combine these two approaches, relying on windows on warm days but letting the MVHR run on low background levels at night.

The house also has a 32 square metre solar PV array on its roof, and selling energy back to grid means that rather than paying for electricity, the family earn on average £1,500 net for it every year. Meanwhile rainwater is collected from 80% of the roof space and filtered into a 2,500 litre tank in the basement — from there it is used for the toilets, washing machine, and a dedicated spray tap in the kitchen.

Bat boxes and bird boxes were also built into the house and garden walls during the build to encourage biodiversity. And other natural and recycled materials abound through the property too — there's reclaimed brass ironmongery, recycled structural timbers, kitchen surfaces made from recycled glass, a limecrete slab under the new extension, plus 200 year old Canadian maple, taken from a demolished local factory and used for the kitchen, window seats, balcony and elsewhere.

The house has been the subject of extensive monitoring for the last four and a half years by a team from the Zero Carbon Lab at Birmingham City University, led by Professor Lubo Jankovic. Every minute, sensors collect twenty different ▶

Photos: Martine Hamilton Knight / Richard Stanton / John Christophers

parameters including indoor air temperatures, relative humidity, and CO_2 concentration; the energy produced by each of the solar thermal and wood burning stove; and the electricity generated, consumed (within the house) and exported (to the grid) by the solar PV system.

One research paper by Jankovic and his colleague Dr Halla Huws examined whether ZCH could remain zero carbon in future — or whether it might need air conditioning or other electrical systems to cool it down in future as the climate warms. Modelling the house, they found that applying two passive shading devices — a brise soleil and external louvres to the south west facade — would help to prevent overheating in future, but the effect diminishes as temperatures rise. However, they found combining this with some form of free cooling, such as using the MVHR's summer bypass feature, would cut overheating by 59% in the year 2080 (or 95 hours over 28C).

Jankovic's research points to the difficulty of designing a building that will have low carbon emissions and high occupant comfort both now and in the future — both our buildings and their occupants will need to adapt to some extent. Speaking to Passive House Plus, he says we may need to retrofit our buildings with passive cooling systems in future, or even design insulation systems that can be later peeled off. So far, 99% of indoor temperatures recorded have been below 28C.

But his research emphasises the importance of modelling new buildings under future climate change scenarios, and of monitoring temperatures inside them, as indoor environments may get slowly warmer over the coming decades without occupants noticing. (Of course overheating is something that will effect all buildings as the climate gets warmer, not just well insulated buildings, which may actually be better protected — see page 72).

Jankovic had yet to fully process some of the other data relevant to indoor comfort at the time of going to print. However, he sent Passive House Plus raw indoor temperature and relative humidity data from April to September of this year. The data shows temperatures in the studio, study, bedroom, and living room remaining relatively stable around the 20C mark, with occasional spikes over 25C in the bedroom during hot weather. Relative humidity is generally at a healthy level between 40% and 60%, though there are regular peaks and troughs within this range, as the sensor is located in the kitchen.

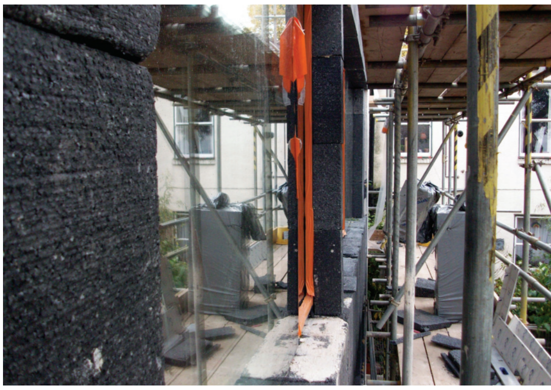
The retrofit, Jankovic and Huws also calculated, slashed the building's annual heat demand by 96%, from 59MWh to just 1.78 MWh, while annual carbon emissions have been cut to 21,000 kg of CO_2 to minus 660g — meaning the building saves more carbon than it now produces, making it truly zero carbon.

But what do the occupants say? "We've become used to the comfort levels in the new house, which we take for granted," Christophers says. He recalls one anecdote from a freezing winter. "One morning I was going around the house when it was very cold [outside], I think it was -17C, and I think the only place we had condensation was on the lock on the front door."

But for Christophers the project was about more than creating a comfortable home for his family — he also wanted to develop a very public demonstration that sustainable building and great architecture go hand in hand. "I think the power of buildings to inspire people is amazing, so I was very keen to not just do a passive house or an eco building," he says, "but really to look at this project as a microcosm of how we can move to a new architecture in design terms."

This meant an emphasis on natural materials and light, with lots of glazing high up in the house,

“We need to look at the challenges of climate change and make a new architecture out of it”



where the daylight is strongest. “This leads you architecturally to more vertical spaces where you funnel the light down,” he says. “We’re bouncing natural light deep, deep into the plan.”

He adds: “I think it’s really important that we move away from the mindset that for an eco-build, it has to have tiny windows.”

“That’s one example of how the architecture and the environment come together,” he says. “We need to look at the challenges of climate change and make a new architecture out of it.”

The only ‘mistake’ Christophers’ has had to correct in five years is the front door — which was originally installed on a timber frame that moved with seasonal humidity, creating some minor draughts. “We’ve just recently rebuilt that door on a more stable thermally broken frame which I think has made a huge difference,” he says.

“In every other respect the building has performed far better than we could have dared to hope.”

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(p59, clockwise from top) single skin clay block walling in progress; Neopor insulation fitted around frameless glass windows on the rear elevation; Enersign triple-glazed window being installed in the new clay block wall, with external insulation fitted to the window frame; laying the clay floor screed; the 200 year old Canadian maple, before and after sanding; fitting the reclaimed maple lining to the top floor dormer window; (p58, clockwise from left) a roof light helps to illuminate the double-height living area; the stair's open treads allow light to filter down; the front of the original house and hardstanding where the new extension is built

SELECTED PROJECT DETAILS
Clients: John Christophers & Jo Hindley
Architect: John Christophers
Contractor: Speller Metcalfe
M&E engineering & CFSH assessment: Leeds Environmental Design Associates
Structural engineering: Shire Consulting
Monitoring: Zero Carbon Lab, Birmingham City University
Solar thermal: Thermomax (now Kingspan Renewables)
Quantity surveyor: Allman Woodcock
Lime plaster: Ty-Mawr
External wall insulation: Sto
Earth blocks: Sumatec
Cellulose insulation: Warmcel
Wall ties: Ancon
MVHR & windows: Green Building Store
Wood burning stove, solar install & PV: Greenshop Solar
Roof windows: Fakro
Roof lights: Vitral
Kitchen work surface: Bottle Alley Glass
Recycled ironmongery: William Ironmongery
Rainwater harvesting: Rainharvesting Systems
Low flow WCs: Ideal Standard

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PROJECT OVERVIEW:

Building type: 1840's solid-brick end terrace house, internal floor area of 100 sqm originally, extended to 205 sqm

Location: Inner city Birmingham, West Midlands, UK

Budget: £350,000 (£47,345 accounting for energy efficiency retrofit to original property including all renewables, new windows and building fabric upgrade)

Space heating demand (after): 7.3 $kWh/m^2/yr$ (PHPP)

Primary energy demand (after): 41 $kWh/m^2/yr$ (PHPP)

Measured energy consumption
Before: 410.64 $kWh/m^2/yr$
After: 27.15 $kWh/m^2/yr$

Environmental assessment method: Code for Sustainable Homes level six (original 2008 version, i.e. without allowable solutions etc)

Energy bills
Before: not available
After: £1,500 net income (including feed-in tarriff)

Airtightness (at 50 Pascals)
Before: 28 $m^3/hr/m^2$
After: 0.97 $m^3/hr/m^2$ (or N50 = 0.57 ACH)

Original walls
Before: 215mm solid brickwork, 12mm lime plaster internally. U-value: 2.4 W/m^2K
After (front elevation only): 215mm solid brickwork with stone dressings, followed inside by 12mm lime plaster, 25mm softwood battens/drained cavity, breather paper, 350mm Warmcel 500 blown cellulose insulation, 75mm timber stud framework, Pro Clima Intello Plus airtight membrane, 19x44mm softwood clamping battens, 12mm Glaster lime plaster on expanded metal lath. U-value: 0.11 W/m^2K
After (elsewhere): 8mm reinforced render system externally, 280mm Sto Neopor EPS insulation with no mechanical fixings, 215mm solid brickwork,12mm Glaster lime plaster. U-value: 0.11 W/m^2K

Extension walls
8mm reinforced render system, externally, 280mm Sto Neopor EPS insulation with no mechanical fixings, 203mm hydraulically pressed load-bearing unfired solid clay blockwork,12mm Glaster lime plaster. U-value: 0.11 W/m^2K

Original roof
Before: Slates on softwood battens, on roofing felt underlay, on 82mm rafters over roof void, over 75mm ceiling joists with 50mm mineral wool insulation between U-value: 3.7 W/m^2K
After: Slates on softwood battens, on roofing felt underlay, on 82mm rafters over roof void over 450mm Warmcel 500 blown cellulose insulation, 100mm secondary timber framework, Pro Clima Intello Plus air-tight membrane, 19x44mm softwood clamping battens, 12mm plasterboard ceiling. U-value: 0.08 W/m^2K

Extension roof: PV and solar thermal panels on Alwitra roof membrane, on 18mm WBP ply deck, on 100mm cellulose insulation board, over 400mm timber I-beam rafters with 400mm Warmcel 500 blown cellulose insulation, Intello Plus airtight membrane, 19x44mm softwood clamping battens, 12mm plasterboard ceiling. U-value: 0.08 W/m2K

Existing floor
Before: 10mm carpet, on 18mm floorboards, on 130mm timber floor joists, over ventilated cellar. U-value: 3.2 W/m^2k
After: 70mm compacted clay finish, on hardboard protective layer, Pro Clima Intello airtight membrane, on 18mm existing floor boards treated and retained, on 182mm timber joists treated and retained, with Warmcel dry-blown cellulose insulation between joists, on 100mm cellulose fibre insulation boards under-drawn, over ventilated cellar U-value: 0.10 Wm^2K

New floors: 75mm compacted clay finish, on 100mm limecrete slab, on DPM, sealed to Pro Clima Intello airtight membrane, on 250mm insulation boards, on sand blinding, U-value: 0.10 W/m^2K

Windows
Before: single-glazed, timber windows. Overall approximate U-value: 5.40 W/m^2K
New triple-glazed opening windows: Enersign triple-glazed composite timber windows and doors, warm edge spacers, argon-filled, two soft low-E coatings. Overall U-value: 0.65 W/m^2K

New triple-glazed fixed windows: Frameless triple-glazed units sealed to building structure, warm edge spacers, argon-filled, two soft low-E coated. Ug = 0.53 W/m^2K

Opening roof lights: Fakro thermally-broken triple-glazed roof windows with thermally-broken timber frames. Overall U-value: 0.81 W/m^2K

Fixed roof lights: Frameless triple-glazed units sealed to building structure, warm edge spacers, argon-filled, two soft low-E coated, Ug = 0.55 W/m2K.

Primary heating system: 8 square metre solar thermal array feeds 850 litre thermal store hot water cylinder. From this, one towel radiator in the shower room is fed. In very cold weather, the Lenius 7kW wood-burning stove is lit — 80% of the stove heat tops up the thermal store, 20% is space heating.

Ventilation:
Summer and spring daytime: natural ventilation using tilt-and-turn windows supplemented by secure insect-screened low level inlet shutter on garden elevation, and opening high level rooflights to stairwell creating stack effect
Winter and spring night time: Itho Eco4 MVHR unit (by Green Building Store) to all rooms, manufacture's thermal efficiency 92% or better.

Solar PV: 32sqm panels, 5kWp, average yield since installation 4000kWh

Cork bungalow upgrade phased over 12 years

It's taken Mick Kiernan more than 10 years to upgrade his Cork bungalow, and it's still not finished. But along the way he discovered the passive house standard and let its principles guide his way towards a warm, airtight and healthy home.

Words: John Cradden

There are many pathways to passive house 'enlightenment' depending on whether you're a

Photos: John Roche

contractor, an architect or a home-owner, but there can't be many paths as long as Mick Kiernan's.

The incremental transformation of his large detached bungalow in Clonakilty, Co Cork, from a cold and draughty property to a warm, comfortable, cheap-to-run home with airtightness close to the Enerphit standard was achieved by a practical yet systematic problem-solving approach over a period of some ten years.

"Both the house and I developed at the same time to a certain extent, because a lot of the problems people would have renovating was stuff I also came across, investigating, researching and solving," says Kiernan.

It helps, of course, that he works as a domestic energy consultant with his own company, Rebel Energy, and counts certification as a passive house consultant among his qualifications. But he didn't start out ten years ago aiming to build a passive house — he only stumbled across the concept later through his interest in building physics.

In addition, Kiernan has rigorously measured the before-and-after effects of the key phase of the work (which began after 2010). This is experience worth taking note of if you have an interest in retrofit.

When Kiernan and his wife Ann bought the 1970s 210 square metre property as a fixer-upper in late 2003, shortly after moving to Clonakilty, he was aware it came with many problems. It had an old and poorly fitted boiler, leaking copper pipework, and poor insulation, airtightness and ventilation.

Kiernan now believes that poor airtightness – most pointedly at large recessed ceiling light fittings in all rooms – meant the house struggled to reach 17 or 18C, even with the heating system on all the time. "I remember a postage stamp size piece of paper being swept from the palm of my hand and up through a fitting when my hand was about a foot away from the fitting."

This sort of first-hand experience of the building's poor performance informed the upgrade process. "Our plan was to live in the house for at least all four seasons and then decide on the works." In the interim, he installed a 7kW multi-fuel stove and added 100mm of fibreglass insulation in the attic "to make the house somewhat liveable while we decided how we would remodel the interior".

By 2005, they figured out what they wanted to do besides the interior remodelling and re-wiring, and this included completely new plumbing, the relocation and replacement of the old oil boiler with a more efficient model, the replacement of all radiators and valves, new ceilings, and an extensive upgrade of the heating controls.

"The following winter, the house went from being unable to be heated past 17C or 18C, to heating up to a comfortable temperature in 30 minutes and I thought, 'happy days'," says Kiernan. But Kiernan soon became aware of the house's poor indoor air quality.

"I soon discovered that the house was severely under-ventilated and so researched how best to ventilate," he said. "It was while doing this that I started to read up on all things to do with the wonderful world of building physics, how one thing affects the next etc, and the different mechanics of heat loss and their effects."

After researching ventilation systems he decided to opt for MVHR (mechanical ventilation heat recovery), and installed a system in his attic from Irish manufacturer Proair, which had a "stark and immediate" effect on indoor air quality.

It was at this point he also trained up on airtightness testing and thermal imaging surveying, and then tested his own house, which came back with a respectable result of 3.5m^3/hr/m^2 at 50 Pa. Kiernan says that aside from his decision to slab and plaster the ceiling, the building had some favourable aspects with regard to airtightness. Original external walls were wet plastered when built, and the building's simple shape may also have helped.

Kiernan did more research, which led him to learn of the passive house concept and its "demand for attention to detail, especially around the building fabric".

He trained as a passive house consultant in 2009. "A natural follow-on was to model my house in PHPP and see what could be done to bring the house, while comfortable enough, as close as practical to passive," he says. The only restriction was that the ground floor had to remain untouched — the family didn't want to move out, and Ann was keen to keep their existing floors.

Kiernan had a plan by 2011, but he is scathing ▶

'Comfort in the house has improved very significantly with very little energy'

about how much time he subsequently wasted in trying to find a contractor who understood what he wanted. "I have lost count of the number of so-called low-energy builders I interviewed who didn't understand the concept of a thermal bridge, airtightness or building physics."

Kiernan finally met contractor Tim O'Donovan of Sustainable Building Services, whose buildings have achieved some of Ireland's best airtightness results, at a nearly zero energy building (NZEB) open day event in 2013. O'Donovan had just completed a passive house retrofit for Doris Knoebel in Clonakilty (as featured in issue 7 of Passive House Plus). "Mick was one of our visitors and he saw what we were doing there," say O'Donovan. "He knew what he wanted to do since he's an engineer himself and had been looking for someone to do the work for him, so he commissioned us then."

The match sounds like it was destined to work out well given both parties' strong belief in doing things properly and thoroughly. O'Donovan says: "It's the old adage of do it once and do it properly and not have to go back, and Mick was very much of that mindset, which is fantastic." So with this meeting of like-minds, the building fabric works began in July 2014, and went on for six months. As part of the latest upgrade works, Grainger Energy Solutions externally insulated the walls with high density Rockwool. Kiernan had previously hoovered loose fill polystyrene bead from the wall cavity and had it fully filled with platinum bead.

O'Donovan replaced the old concrete roof tiles and felt with new clay tiles and a Siga wind-tight breather membrane, while some rafters were re-aligned and box-ends re-constructed. The floor of the cold attic was also heavily insulated with cellulose above the existing joists, and the new external wall insulation rises up to meet the attic insulation.

The new triple-glazed windows were also set flush with the outer wall and airtightened against the inner leaf walls, while the external insulation also wraps the window frames. The before and after pictures of the house reveal how much ▶

more modern it looks now, with its smooth acrylic rendering.

"There was a definite emphasis on making the look of the house more contemporary," says Kiernan. "I paid a lot of attention to which windows didn't need an opening sash — for practical or fire safety purposes — because as windows can be the poorest performer for heat conduction of any wall, I wanted to optimise each opening."

Kiernan has been carefully monitoring his house's energy performance since 2010, as much for personal as professional reasons. It started with an hour meter on the conventional oil boiler, which he installed in a bid to determine whether it was more economical to run the heating periodically or continuously. But he has now extended this to monitoring the internal and external temperatures, and relative humidity, at five-minute intervals.

"I subsequently continued monitoring the house, initially from personal curiosity, but the gathered data is very instructive for helping explain the inter-relationships between heating, ventilation and moisture load to clients."

So with the accumulation of all his data, what's the verdict? "As the [building fabric] works are not yet a year complete I don't have enough data to do a complete pre and post works comparison, but a couple of things have become clear: the general feeling of comfort in the house has improved very significantly with very little energy input."

"When the data is in I wouldn't be surprised to see a reduction of at least 65% in oil usage from pre the deep retrofit, and more than 90% from when we moved in in 2003. And the stove has become largely an ornament."

As for airtightness, that's still a work in progress, but advances have clearly been made as it is down to 1.4m³/m²/hr, compared with 3.5m³/m²/hr previously. Kiernan expects to hit the Enerphit target of 1.0 ACH at 50 Pa but the building's space heating demand is almost double the Enerphit target of 25 kWh/m²/yr – perhaps owing to a far from ideal form factor. The building's 210 sqm of floor area is spread over a considerable area, meaning a significant amount of external surfaces through which heat can escape, in spite of the high spec fabric.

And in terms of the cost? The total cost – for a renovation project which goes far beyond energy, including a new roof, electrics & drainage system – came to around €100,000 but there were "few surprises" thanks to the time taken to detail out the project, according to Kiernan. "In fact, the budget was helped by being able to trade-in my old roof tiles and I even managed to sell the conservatory online."

And aside from anything else, he says: "You can't put a price on quality of life".

SELECTED PROJECT DETAILS
Energy consultant & retrofit design: Rebel Energy
Project management: Rebel Energy
Contractor: Sustainable Building Services
MVHR: ProAir
Windows: Munster Joinery
External insulation contractor: Grainger Energy Solutions
External insulation: Rockwool
Airtightness tapes and membranes: Siga
BER assessor: John O'Leary

PROJECT OVERVIEW:

Building type: 1977 built 210 sqm detached cavity wall bungalow

Location: Clonakilty, Co Cork, Ireland

Completion date: December, 2014

Budget: €100,000 (including non-energy efficiency measures such as overhaul of electrical supply, new roof covering and rafter re-alignment, re-arrangement of foul and rainwater pipework)

Passive house certification: N/A

Space heating demand (PHPP): 46 kWh/m²/yr

Heat load (PHPP): 18 W/m²

Primary energy demand (PHPP): 130 kWh/m²/yr

Airtightness (at 50 Pascals): 1.4 m³/m²/hr at 50 Pa (airtightness work not yet complete and expect to achieve a result of less than 1 m³/m²/hr at 50 Pa and less than 1 ACH)

BER (after): C1 (157.3 kWh/m²/yr)

Thermal bridging: EWI layer installed 600mm below finished floor level and rising past soffit to meet attic insulation, new thermally broken window frames moved out and wrapped in reveal EWI insulation. Y-value not calculated.

Ground floor: Original concrete floor untouched for various reasons.

Upgraded walls: EWI render with 200mm Rockwool insulation (batt edges buttered to prevent air flow at back of insulation) mechanically fixed to original pebble dashed 100mm outer leaf, 60mm platinum bonded bead insulated cavity, 100 mm inner leaf, 30mm internal sand/cement render. U-value: 0.139 W/m²K

Upgraded roof: New clay tile on battens, on Siga Majcoat wind-tight breather membrane, on rafters over cold attic, with 300mm cellulose on 100mm fibreglass insulation between existing ceiling joists, on sealed plasterboard and skim. All services through ceiling sealed with Siga Rissan tape. U-value: 0.12 W/m²K

Windows: Munster Joinery Future Proof triple-glazed passive house certified uPVC windows, with argon fill. Overall U-value of 0.69 W/m²K

Heating system: 10 year-old 87.5% Firebird Popular 120 conventional oil boiler supplying radiator heating and 280 litre tank for domestic hot water. Two heating zones plus DHW zone. Rudimentary but effective boiler management control system on boiler.

Ventilation: Proair PA600 MVHR system with certified efficiency of 90%

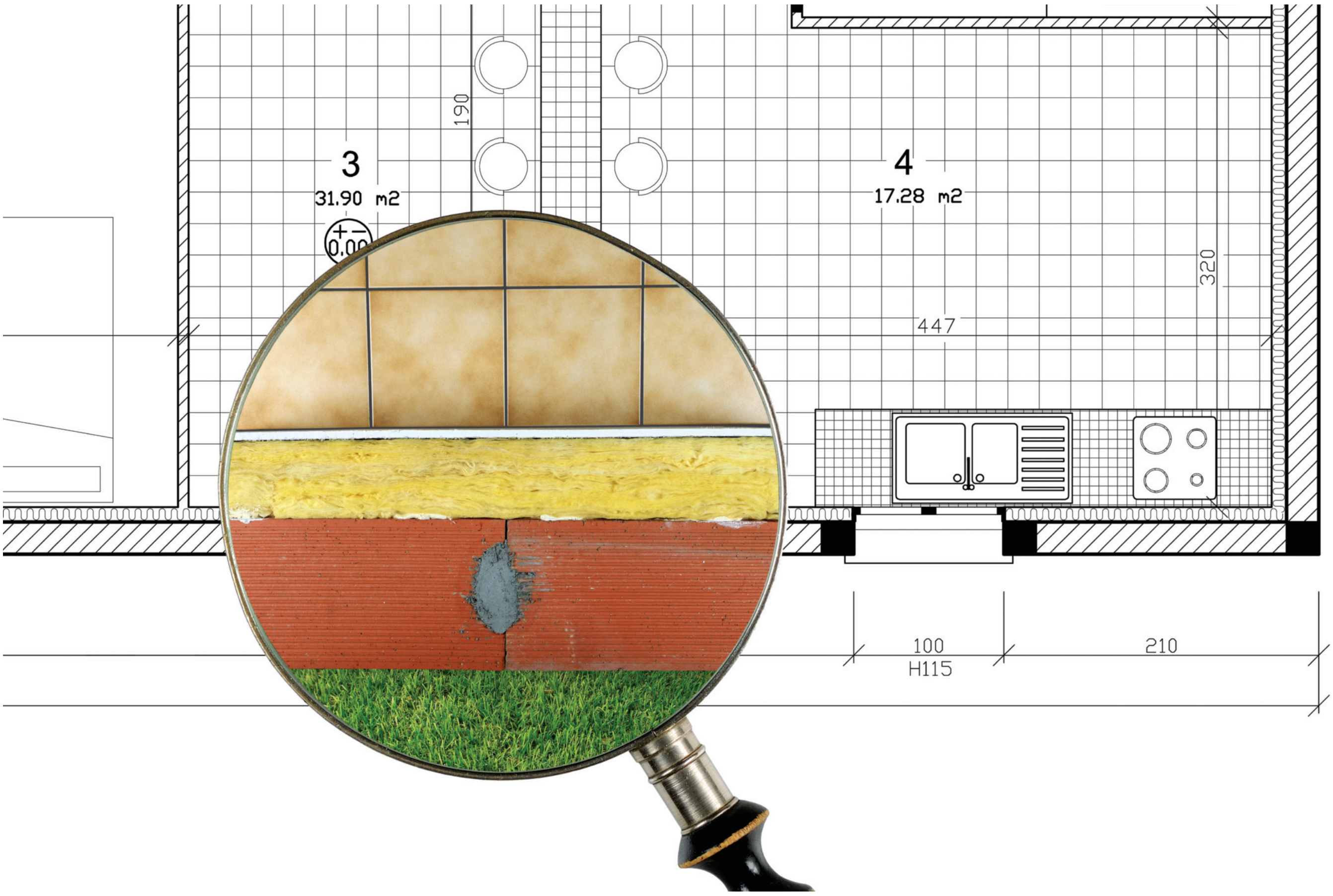
Electricity: Plan to install a substantial PV array on south roof in future

Green materials: New clay tiles to roof, cellulose insulation, old conservatory was sold/recycled

(above, left) the old roof tiles were stripped off, and replaced with new clay tiles over a Siga Majcoat wind-tight membrane; (above, right) internal airtightness detailing around the frames of the new Munster Joinery passive house certified windows; (below) the walls are externally insulated primarily with 200mm high density Rockwool, though moisture-resistant polystyrene is used around the perimeter down to 600mm below finished floor level; (p65) the new triple-glazed windows were moved out to be flush with the original outer leaf, and then the external insulation was installed, as shown in these before and after photos

MATERIAL IMPACTS

Image: Therry



Quantifying the greenness of construction products

For decades now, European countries have been regulating the amount of energy new buildings can consume for heating and electricity. But as these standards get ever tighter, is time to start controlling the embodied energy and wider environmental impact of building materials — and what's the best way to do it?

Words: John Hearne

As building regulations tighten and sustainable building moves further into the mainstream, the building materials sector has been in a frenzy to get on the bandwagon. Greenwashing has of course been with us for years, and takes many forms.

Prefixes like 'eco' and 'enviro' pop up behind established brands, while promotional literature moves away from product imagery to generic shots of blue skies and rolling hills. Advertising copy gets selective — the Forest Stewardship Council (FSC) certification might only apply to the veneer, and not the core timber, while what has always been standard practice can suddenly get pushed out into the limelight, re-invented as a green innovation. You get vague, unverifiable claims, while the world 'natural' pops up everywhere, as if naturally occurring substances (eg asbestos, formaldehyde and arsenic) are universally good.

Despite the introduction of a raft of advertising standards across jurisdictions in order to try and combat the spin and encourage the science, the central problem here is that the main source of information on most of the building materials that we use are the companies that make them – meaning the companies promoting genuinely greener materials can get lost in the marketing noise.

Dr Craig Jones is director of Bristol-based consultancy Circular Ecology. He says: "You see them when you walk around the large trade shows. I won't name any names but everyone knows who the large ones are. Every product, every material seems to be billed as sustainable. As a sustainability professional, it gets a bit tiring because not everything is sustainable in construction at the moment. Most things are quite far off and yet the word 'sustainability' gets bandied around all the time."

In this part of the world, there are almost no statutory obligations to monitor, let alone curtail the environmental impact of the building materials we use. Regulation has concentrated on the energy needed to run the building rather than the energy needed to build it, and there were good reasons for that. Our building stock could

only be made habitable by burning a lot of fuel.

Now however, as the regulations tighten and the process of breaking the fossil fuel habit becomes entrenched, the embodied energy in our buildings [ie all of the energy associated with the manufacture of the building materials and construction of the building] has come into sharp focus. Looking at Part L of the Irish building regulations and taking the 2005 regulations as a baseline, the first wave of reform saw a 40% reduction in operational energy [the energy used for heating, cooling and electricity] in 2008, followed by a 60% reduction from that same baseline in 2011. Changes to the energy performance standards in the UK (under separate versions of Part L in England and Wales, Part F in Northern Ireland and Section 3 in Scotland) have so far been less dramatic, but profound change is coming: under the EU's energy performance of buildings directive, all new buildings must be nearly zero-energy by 2021.

Dr Jamie Goggins is a senior lecturer in civil engineering at the National University of Ireland, Galway. "There are lots of ways to achieve the reduction in operational energy," he says, "but one of the key things is obviously to make the building fabric more thermally efficient, and one way of doing that is to add more insulation to it. That means there's an increase in material used in the building envelope. The more material you have, the more you drive up the embodied carbon and energy."

As operational energy reduces, embodied energy — as a portion of the total energy the building will consume over a sixty year life — climbs steadily higher. Goggins and his team at NUI Galway have explored a wide range of local and international studies in their research. To make things simple, he zones in on one – a 110 square metre cavity wall house.

"If we take the 2005 [Irish] regs, the percentage of embodied to operational energy is about 20-80. Then under the 2008 regs, it's 25-75. In the current regime, it's about 40-60 and when it comes to nearly zero energy buildings, it will be about 50-50."

There is, he points out, quite a bit of variation within these figures, depending on the sources of operational energy and the materials chosen in construction, but the trajectory is unambiguous. "The key message here is that as you move towards more energy efficient building in terms of operational energy, the percentage of embodied energy gets more significant," he says.

The other point he makes is that there is a significant material difference between operational and embodied energy. "Embodied energy is all about the here and now," he says. "These are the emissions being put into the atmosphere today, whereas operational energy emissions are spread over sixty years…Surely it's a lot less onerous on the environment to deal with the operational side of things over the 60 years rather than sending it into the atmosphere all in one go, or at least over a short period of time."

Moreover, these figures make some pessimistic assumptions about where the energy to heat and cool our buildings will come from over the next sixty years. As the grid decarbonises, the proportion of energy that comes from fossil fuels will continue to decline, thereby forcing up the relative proportion of energy expended in construction.

Goggins continues: "The greenhouse gasses that we're giving off today in making the material and constructing the building, we can't change that, we can't roll that back, but the operational stuff we have 60 years to deal with."

Against this backdrop, the case for regulating exactly what goes into the buildings we build becomes compelling. In the UK, the civil engineering sector has started to address the issue. Craig Jones of Circular Ecology says that all new water infrastructure must undergo a whole-life embodied carbon assessment, while new rail developments over a certain size must measure their embodied carbon impact.

There's no equivalent in the buildings sector. Certification programmes like Breeam offer points for completing life cycle assessments and reducing the environmental impact of a building, but there is, as yet, no statutory requirement for such work.

Even the voluntary codes have drawn criticism from within the green building sector. The BRE Green Guide to Specification, which is used as a means of gaining credits under the Code for Sustainable Homes, has come in for a lot of negative attention. The Alliance for Sustainable Building Products in the UK has issued a lengthy critique of the guide, pointing to, among other things, its lack of transparency.

It says: 'None of the data used to generate Green Guide ratings is open to public scrutiny. The principle of transparency is a central theme of international LCA standards [life cycle assessment] (ISO 14040). It is common practice to 'black box' sensitive information but not the entire data set. As the UKGBC [UK Green Building Council] Task Group have indicated, the principle of transparency is critical to foster trust and learning.'

At a European level, CEN/TC 350 is the committee responsible for developing standardised methods for the assessment of the sustainability aspects of buildings and civil engineering works. In recent years, it has put much work into developing assessment methods for construction materials, and in particular, developing core rules for the development of Environmental Product Declarations (EPDs) for construction products.

As far as the future of building materials is concerned, the EPD is set to become a very familiar term. Craig Jones says that EPDs offer something approaching a common standard. "Anyone measuring the environmental impact of construction would be recommended to use these standards because they are official EU-wide standards, applicable all around Europe. They've been out since 2011/12, and while it does unfortunately take a long time for standards to become influential, they do help to bring consistency across Europe."

An EPD is essentially a standardised document which quantifies the life-cycle environmental impact of a particular product or system. Each one is independently verified and registered, and breaks down the impact of that product or system across a range of categories, including global warming potential, ozone depletion, acidification and eutrophication.

"An EPD is actually similar to the nutritional label that you would find on a box of Corn Flakes," says Pieter Stadhouders of Netherlands-based consultancy EcoReview. "Similar in that you describe the characteristics of your product in a way that is easy to understand, consistent and that it complies to the environmental regulations."

It's important to say that having an EPD doesn't mean that the product in question is in any way superior to its alternatives. Rather, it cuts a swathe through the greenwash and describes the environmental impact of that product in precise, scientific terms. Databases of EPDs are slowly becoming the gold standard in Europe, superseding earlier data sets which captured only the embodied energy and carbon of building products. ▶

Photo: Triptyque

Presentation of Environmental Product Declaration certificates to a number of prominent European construction product manufacturers at an October 2014 Eco Platform event



We're also seeing the beginnings of regulation around life-cycle energy, and here too, EPDs are playing a central role, particularly in the Netherlands, where a statutory framework for reducing the environmental impact of buildings is at a more advanced stage than anywhere else in Europe.

Pieter Stadhouders says that since 2012, to get a construction permit in the Netherlands for any building larger than 100 square metres, an environmental impact calculation of all the materials in the building is required. "The indicator which they use is called the Environmental Cost Indicator, or ECI, and that's a summation of eleven different environmental impacts which are weighted to give one figure."

This regime facilitates the accumulation of a wide range of data, which, it's envisaged, will lead to the development of a series of ECI benchmarks for different categories of building. From there, it will then be possible to encode minimum values into the building regulations.

"Probably in the future there will be regulations on maximum ECI per square metre," says Stadhouders, "or there will be some sort of penalty if you have a high ECI per square metre …It's not yet determined on how this policy will work, but they're saying, 'ok we want to prepare the markets to calculate this and get a reference'."

At a national level in the Netherlands, much of the work has centred on building the databases which will inform the design of whatever policy is eventually settled upon. Stadhouders explains that 'category one' data was essentially first generation data gleaned from work done by some sectors, including concrete, to measure the environmental impact of its products. This data, while it fell short of the standards set by EN 15804 – which governs the development of EPDs – provided the authorities with a baseline dataset with which to begin assessments.

"Then they asked different industries — wood, cement, gravel, glass and so on – to compile an EPD for the whole industry. This phase took about two years to complete, and gave the 'category two' data, which was validated data under the EN 15804 determination method, even though it was not producer specific." The third and current phase comes with the publication of validated, product-specific EPDs. This is the most detailed dataset yet and comprises 'category three' data.

The authorities in the Netherlands are now in the process of phasing out that first database, by introducing incremental penalties for the use of category one data, thereby incentivising the industry to adopt a more scientific way of measuring the environmental impact of the materials it uses.

In Ireland and the UK, the political climate for improved environmental regulation may have soured in the last few months, with the scrapping of the zero carbon homes plan in the UK, while in Ireland, political pressure has been brought to bear on a local authority that has sought to make the passive house standard a minimum for new buildings. So there would seem to be little prospect here for improved regulation of embodied energy and carbon in buildings.

But while the regulatory environment may not be up to it, Pat Barry, executive director of the Irish Green Building Council, believes that the market may do a lot of the work that the government shies away from. "Manufacturers will only go and get an EPD if they know they're better than the average," he says, "so it encourages manufacturers who believe they have performed better and have made an effort to reduce their impacts to go off and get the verified data. Getting an EPD gives a competitive advantage."

He also points out that Breeam and Leed, two of the leading green building certification programs, award credits just for having an EPD, creating further competitive pressure. Already, a broad number of product manufacturers – including many whose wares are advertised in these pages – have either acquired or are in the process of preparing EPDs for their products.

Barry believes that those competitive pressures will continue to push the sector in the right direction. "Pretty much any large office project will get some sort of certification so when an architect rings a manufacturer and says, 'look we have to get this credit, we need an EPD, have you got an EPD? You don't?' If that happens with only 5% of specifiers, they start to see a change, and manufacturers start asking, 'What's an EPD? I suppose we better get one because we're losing 5% of our market share if we don't have one.'"

As EPDs become more common, he suggests, it will be easier for government to regulate. "You can't regulate for something that is expensive and that is being done by very few people, but once it becomes mainstream, once it becomes common practice, then it makes it more feasible for local authorities and governments to regulate for it."

Craig Jones in Bristol is a little less optimistic. He believes the virtuous cycle of competitive pressure leading to regulatory action is still a long way off. "I think there's a bit of chicken and egg in the UK at the moment…There's probably not enough activity from manufacturers and the government's not regulating anything either."

He points out however that the advent of building information modelling, or BIM, holds out the prospect of mitigating the administrative burden that a fresh layer of regulation would add to a sector that has had to deal with a lot of additional regulation over the past decade.

BIM is all about creating a comprehensive digital representation of a building. As EPD databases become more comprehensive and BIM software more powerful, it's possible to envisage a time when making the calculations needed to establish the life cycle environmental impact of a building will become much simpler than they are today.

"If these assessments could be integrated into the tools that designers are already using," says Jones, "it becomes a lot easier… Then hopefully – because it's so much easier to do an assessment — government will get more comfortable about regulating."

OVERHEATING

a growing threat that mustn't be ignored

As the climates gets warmer, overheating in buildings is likely to get worse — particularly given the modern architectural preference for huge expanses of unshaded glass. But what really causes overheating, is it really worse in low energy buildings, how do passive houses fare, and what can be done to prevent it?

Words: Kate de Selincourt

In 2011, England's Health Protection Agency officially described overheating as a public health issue.[i] Since then, a number of reports and studies have emerged making it clear the problem is not uncommon. Some instances have been severe, making news headlines, and some have had serious consequences for building developers as well as the occupants, with protracted legal disputes reported.

Despite the temptation after a summer like 2015 to say "overheating – I wish!", this is not a trivial issue. Death rates start to rise when peak outdoor temperatures climb to around 24C. And in less heat-inured areas like the north-east of England, death rates start to creep up even at 20C[ii].

Given that people, especially the frail and vulnerable, spend most of the time indoors, there is little doubt that indoor overheating drives these impacts. One survey in England found that 20% of bedrooms were exceeding the recommended CIBSE limit of no more than 1% of night time hours above 26C, even in an average year. Occasional properties suffered indoor temperature peaks above 30C. Night-time temperatures above 24C impair sleep and are likely to pay a big role in the extra illness and mortality associated with warm weather.[iii]

And even for dwellings that don't currently overheat, there is a real danger that they will do so in future. By the 2040s, summers as hot as 2003 — when over 2,000 excess heat-related deaths occurred in the UK — are expected to be very common, with one potentially every other year.

Rob McLeod of the BRE calculated that in 30 years' time, in warmer summers most low energy dwellings as currently designed will frequently experience temperatures above 28C.

There is no statutory definition of overheating in the UK or Ireland at present, however, three possible definitions are listed in the table below.

Definitions of overheating

Standard	Definition	Notes
CIBSE Environmental Design Guide (2006)	Limit of 1% annual occupied hours above 28C (living rooms) and 26C (bedrooms)	Widely used
Passive House Planning Package (PHPP)	Limit of 10% of year above 25C	UK Passivhaus Trust proposes to release guidance with tighter limits (see main article)
Adaptive thermal comfort levels BS EN 15251:2007	Sets acceptable indoor comfort temperatures dependent on 'running mean outdoor temperature'	Indoor upper limit ranges from around 26 when running mean is 15C, to around 30C when running mean in high 20s. However, CIBSE guide A 2015 recommends limiting this to 26C.

Photo: Marcophoto

Overheating is an energy issue as well. Reportedly around 3% of the housing stock in England has airconditioning[iv], and the danger is that this will become the norm if overheating isn't better prevented.

Media reports and indeed some in the industry point the finger of blame squarely at low energy building – specifically insulation, and sometimes airtightness too. Professor Li Shao, of Reading University was quoted in the Daily Mail[v] recently as saying: "If you wear a thick coat in winter that makes a lot of sense. But if you wear the same thick coat in summer you will overheat. It is very, very obvious...If you super-insulate houses, then you'll create overheating issues where people will suffer." Lightweight construction is also blamed.

However according to housing associations and local government officials, as quoted in a 2014 Good Homes Alliance report on overheating[vi], dwellings of all ages and conditions suffer from overheating — it's not just low energy buildings. A bedroom with an uninsulated roof or west-facing wall may become very hot by the end of the day, and the fabric may go on radiating heat all night.

By contrast a low energy dwelling will gain little or no heat through the roof and walls, but if solar and internal gains are not controlled, and/or ventilation is inadequate, the dwelling is also at risk of overheating. It is overheating in low energy dwellings that has been receiving the attention, most recently via a study and series of reports by a working group at the Zero Carbon Hub in the UK.

Analysis tools

The Passivhaus Trust agrees that summer overheating "can be a potential problem in all modern buildings because of our preference for much more glazing than in former times."[vii] However, the trust also points out that passive house "is better at addressing this than any other method because it takes account of solar gain and shading as standard within its calculation methodology, and alerts the designer to any potential overheating, enabling it to be eliminated at design stage."

An overheating check, called Appendix P, has also been introduced into the UK's SAP methodology. The assessment is not compulsory, but the checks are nonetheless commonly undertaken during the design of new homes, sometimes at the instigation of the client.

Sadly however, according to Susie Diamond of building physics consultancy Inkling LLP, who contributed to the Zero Carbon Hub's report Overheating – the Big Picture: "It is widely accepted that Appendix P is a bit of a fudge and needs improvement."

The ZCH's industry working group considered Appendix P too easy to pass partly because it "allows assumptions to be included that are unrealistic. For example, that windows are constantly open."

With a similar Part L, and an overheating check in DEAP (Ireland's equivalent to SAP) that is much the same as in SAP (it's no coincidence that it's also called Appendix P), the situation in Ireland is basically the same, according to Cork-based passive house architect John Morehead. "Part L does not really address overheating – it is much more geared in relation to losses. And Appendix P is optional, and it does not really do anything," he says.

"As a result we are seeing supposedly low energy buildings that are very uncomfortable; it is a problem. We changed over to using PHPP instead, as it addresses overheating much better, it's much better at warning when you have too much glazing, which I believe is one of the principal problems."

However, even if Appendix P was an accurate tool for predicting overheating, DEAP and SAP are not design tools, they are compliance tools. By the time someone starts entering the data, they are likely to be under a lot of pressure to fit the predictions around the existing design.

One of the architects participating in the ZCH research complained that "the problem with the design tools is that you tend to apply them when the design is fixed... you are running the SAP calculation to demonstrate compliance."

The architect added: "...to be told late in the process that you've got an overheating risk is not very helpful."

Perhaps the solution lies in the architect's own hands – to establish whether or not there is an overheating problem earlier in the process, while there is still time to do something about it. This is why the Passivhaus Trust, and all good passive house certifiers, recommend that building design is modelled in PHPP at the earliest possible stage[viii].

The Trust's Rules of Thumb document also reminds designers that while PHPP is a good tool, it still depends on the common sense of the designer to enter realistic assumptions, using common sense and good judgement.

Ventilation

In Appendix P, an effective air change rate for natural ventilation via windows is set by a look-up table depending on the degree of window opening (as entered by the assessor) and the type of dwelling. In PHPP the calculation is more nuanced, with actual window sizes and positions included, and allowances made for different ventilation patterns by day and by night.

But nevertheless, as passive house certifier Warm says in a blog post on its website, "it is easy to apparently solve any overheating problem by assuming a high enough ventilation rate".[ix]

There is simply no substitute for common sense and local knowledge. As the Zero Carbon Hub points out: "Occupants are sometimes either unable or unwilling to open windows, and leave them open for sufficient time... for a variety of reasons. These include concerns about security, pollution and noise, especially at night." And an urban heat island (and this can be a very local effect) may drastically reduce the amount of cooling available.

As Susie Diamond adds, even where none of these issues apply, "you can't just blow air at 15C over the occupants all night – they will get cold. It's OK in an office when there's nobody there, but if there are people, especially vulnerable people, sleeping, you can't treat them the same way."

It is important to be realistic with mechanical ventilation too: passive house consultant Alan Clarke warns that even on summer bypass mode, MVHR will still recover around 25% of heat, so for an accurate figure in the overheating calculation in PHPP, the air change rate should be reduced by one quarter.

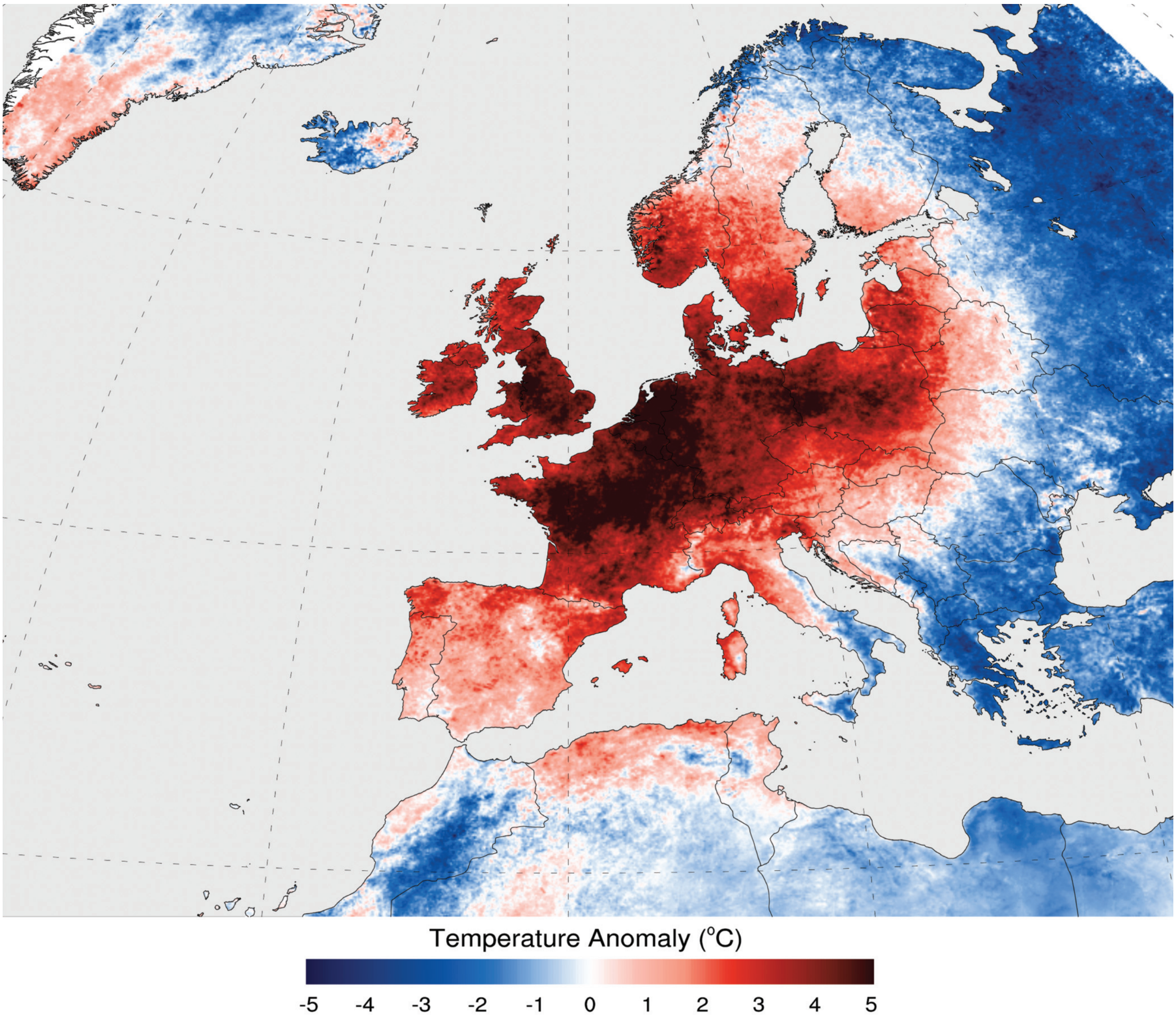
But a highly insulated and airtight building with heat recovery ventilation may have an additional advantage in very hot weather. If the building is closed up and glazing is adequately shaded, it can stay cooler during the day than its conventional equivalent.

If the building has cooled during the night, turning the summer bypass off – in other words, restoring heat recovery – will recover the coolness and keep it in the building. Some MVHR units come with this built in as automatic, restoring heat recovery at a preset indoor temperature – for example, 22 or 23C – if it detects that the incoming air is hotter than this. However, this approach only works when the windows are closed.

Internal gains have been implicated in overheating in small dwellings: homes in the UK tend to be quite a bit more densely occupied than those in continental Europe, leading to higher occupant-related gains per square metre. PHPP now sets different internal gains for winter and summer, to stay on the safe side in each case. For summer it uses the actual gains set by electrical appliances, auxiliary energy and hot water losses for the actual number of occupants, and for the services as designed.

Ventilation and thermal mass

There is sometimes concern that relatively light constructions such as timber frame are ▶



While not as lethal as the 2003 heatwave, which was estimated to have caused 70,000 deaths across Europe, the 2006 European heatwave saw temperature records broken in several countries, including the UK and Ireland, while 1000 deaths were attributed to this event in the Netherlands alone.

more vulnerable to overheating – and that this can be resolved by increasing the thermal mass.

However thermal mass is not a panacea, and cannot simply be added in to 'compensate' for gains from extensive glazing. As Alan Clarke warns, there is a limit to the amount of heat that can be purged from thermal mass via ventilation. He says: "The thermal capacity of air is not that high, and the thermal inertia of materials restricts the rate at which heat can be lost.

"Thermal mass is fine if purging [of heat] can be fast enough, taking onto account likely evening/night time temperatures. A lighter structure, while it will get hot during the day — especially if not ventilated — can be fully cooled at night, so will be cooler for sleeping. It will also be less liable to build up heat day after day in an extended hot spell."

Susie Diamond agrees: "The commonest problem with overheating is where dwellings get a lot hotter than outside during the day, and are not able to cool down overnight.

"If a building is sealed up all day when people are out and the temperature rises to 40C, so long as it cools down within say 20 minutes of people returning home and opening all the windows, that's probably OK. But if it doesn't cool down quickly, that's not all right.

"This is one of the problems with people assuming that thermal mass is an antidote to overheating. In fact if there is a lot of mass, flushing all that heat out may be difficult, especially if for example the building is single aspect, single storey, or the windows do not open very wide. If there is too much mass you can't purge it fast enough, and it simply re-radiates the heat through the night."

Perhaps the most common design problem in buildings that overheat is excess glazing, especially to the south and west. In a non-passive house building this may just be because the client or architect likes huge windows, or perhaps believes that they signify luxury. However in a passive house, extensive south glazing may be there specifically to capture passive solar gains in winter. And there is no doubt that a lot of glazing means a lot of gains – which will then have to be removed if overheating occurs.

According to passive house consultant Nick Grant, it may even be that with very large windows, the effect of shading may be reduced in summer by convection currents circulating between the sunlit and shaded portions of the unit, heating the inside surface of the window.

Furthermore, as Warm warn on their blog, shading calculations are very tricky. "We think it's actually impossible to get the shading 100% 'right' in PHPP," they say. This is especially the case with user operated shading, as it is impossible to be certain if or how it will be used.

Warm advise that a design dependent on large amounts of south glazing is inherently less robust than one achieving its thermal performance with lower levels of glazing – in summer and winter.[x]

To prevent overheating, Rob McLeod of the BRE has a suggestion for passive house designers. Aiming to minimise the spacing heating demand over the whole season, working to the 15kWh/m²/yr target in PHPP, can tempt designers to maximise solar gain. But this clearly also carries risk of overheating when conditions are warmer (as well as increasing the risk of losses when conditions are coldest).

McLeod suggests designers work instead to the alternative certification target of a peak heat load of 10 W/m². This focuses more on insulation and reducing heat loss, since the peak heat

load will occur at a time of very little solar gain. So in this case windows can be become a net loss, and a much more modestly glazed design results, which reduces the risk of overheating.

A building designed in this way may have the additional benefit of being cheaper, and being less vulnerable to last minute issues with super expensive high-performance glazing.

Climate data

SAP and PHPP both divide the UK into a number of climate zones to give average levels of temperature, wind and solar radiation. For Ireland, PHPP contains two climate data sets. But architect John Morehead has examined ultra-local climate data for different parts of the country and has found that when these specific values are entered into PHPP, annual heat demand and heat load can vary by as much as 45% for geographical areas — even on an island as small as Ireland.

> “There was concern from housebuilders that a design could apparently 'pass' the overheating test in SAP, only to overheat and leave them facing a dispute, and possibly considerable expense. They would rather spend a bit more on the design than get into this situation.”

This makes a significant difference both to optimising the design for warmth in winter, but also when guarding against overheating in summer. “For example, using the local data has allowed [us] to ease the U-values depending where the building is situated — here in Cork our winters are much milder than in the centre and east of the country, but the summers are cloudier. This means we can use more south glazing without so much worry about either losses or overheating,” he says.

“The local certifier is happy for us to use this data for [solar] gains, then we use the Dublin data for heat loads as they are more demanding; that way everyone is happy. But in the end, this is not so much about getting the building certified, we are much more interested in making the building work.”

Beyond the drawing board

There is still one big assumption that all designers are making though. However careful their calculations on building performance might be, they are assuming that what they have designed is what will be built. This does not always happen.

For example, the PHPP calculations for a development of semi-detached passive houses in Scotland determined that there would be just 0.2% overheating, ie three quarters of one day per year above 25C.

Yet monitoring showed a period of two weeks when the temperatures in the bedrooms rarely dipped below 25C, despite external temperatures averaging about 18C. As a report by Tim Sharpe and colleagues at the Mackintosh School of Architecture put it: “This represents a significant mismatch between PHPP assumption and reality.”[xi]

A number of issues with the construction were identified. One particular source of unwanted internal gains was uninsulated pipework that ran behind the upstairs walls, connecting the solar thermal panels to the main heat store.

Also, the project did have quite a complicated specification for the building services which included a wood stove for space heating and winter hot water as well as solar thermal.

What next?

Awareness of overheating is definitely increasing. So what practical steps are being taken to tackle the issue at source?

If campaigners succeed in bringing in passive house as the mandatory building standard in Dún Laoghaire-Rathdown and Dublin City, then a much more detailed overheating analysis will be carried out for all new buildings there. However for Ireland as a whole, and the UK, statutory action seems unlikely.

But as Susie Diamond explains, industry itself has reasons to want to change things. “Housebuilders themselves are taking a positive interest in this, as they are starting to feel at risk,” she says.

“There was concern from housebuilders that a design could apparently 'pass' the overheating test in SAP, only to overheat and leave them facing a dispute, and possibly considerable expense. They are coming to the point where they would rather spend a bit more on the design than get into this situation.”

One example that was reported to Diamond’s working group at the ZCH was that of a housebuilder who ended up carrying out extensive remedial works on a recently completed building, “in order to gain building control sign-off and to satisfy the local environmental health officer.”

According to the Hub’s report, even winter temperatures in these apartments exceeded 27C. “During this time, the housebuilder experienced negative media coverage and customer dissatisfaction.” They ended up spending around £100,000 on remedial work.

“If there was an agreed protocol for predicting overheating, then builders could argue that they had followed this protocol and therefore they were not at fault,” Diamond says.

She hopes that such a protocol will be developed, and feels there is a lot to learn from the passive house community: “They tend to be quite ‘real’ and pragmatic; we are hoping to have continuing involvement from passive house people in developing this work.”

Meanwhile, the passive house community itself is not standing still either. Members of the Passivhaus Trust have charged its technical working group with investigating overheating in passive house builds. Certifier and Passivhaus Trust associate director Kym Mead reports that the trust is likely to recommend that designers aim for no overheating, but that 0 to 2.5% of the year above 25C could be considered very good practice; 2.5 to 5% good practice and 5 to 10% merely a backstop result. “The general opinion is that the [PHPP] criteria set at 10% hours over 25C are too high,” he says.

“We are learning more and more about how to build passive house in the UK climate,“ he says, and suggests we should be aiming for zero overheating. “These proposals comes out of the collective will to get this right.”

After all, in the end good building is about far more than certification, it is about comfort, about health, and about satisfied occupants.

[i] Overheating in Homes: The Big Picture, Zero Carbon Hub 2015
[ii] Same as above
[iii] An investigation into future performance and overheating risks in Passivhaus dwellings, Rob McLeod et al, Building and Environment, Volume 70, December 2013, Pages 189 to 209
[iv] Same as [(i)]
[v] “Crazy eco rules that are turning modern homes into ovens: experts warn drive for 'green' homes poses a potentially lethal risk”, The Daily Mail, 10 July 2015
[vi] Preventing Overheating, Good Homes Alliance, 2014
[vii] 'Overheating risk in eco homes', www.passivhaustrust.org.uk, 11 May 2015
[viii] How to Build a Passivhaus: Rules of Thumb, Passivhaus Trust, 2015
[ix] http://www.peterwarm.co.uk/10-most-common-phpp-mistakes/
[x] Same as above
[xi] Towards Low Carbon Homes – Measured Performance of Four Passivhaus Projects in Scotland, Tim Sharpe & Chris Morgan, at Eurosun 2014, 16-19 September 2014, Aix-les-bains, France.

Stress testing your design

One way to gain more confidence about the accuracy of your overheating results (or indeed, about any aspect of your passive house design) is to run a stress test, where plausible extreme conditions are entered into the relevant sheet, to see if the results are a catastrophic failure of performance – or merely make the building slightly less comfortable.

Thus for overheating, certifiers Warm recommend the following “stress” conditions:

- minimum user operated summer shading;
- set mechanical ventilation at half normal rate;
- assume no natural ventilation during the day;
- assume half the achievable night time ventilation (and be careful about assuming internal doors are open).

Stress tests might also roughly test the possible impact of prolonged heatwaves by running the overheating analysis with climate data corresponding to a warmer area – for example, using the London data with its warmer summer nights, when designing a building outside the city. It is also possible to get hold of projected climate data to run a 'future' stress test. Stress tests might be a useful way to compare alternative fenestration designs, for example.

ENERGIESPRONG

The Dutch scheme that could revolutionise retrofit

The Energiesprong initiative is planning to deliver drastic energy upgrades to over 100,000 homes in the Netherlands using a wildly ambitious approach to retrofitting the country's building stock. Now the organisation has moved to the UK, where it is hoping to undertake its first projects next year.

Words: Lenny Antonelli

The Energiesprong programme, which plans to deliver zero-energy retrofits to 111,000 homes in the Netherlands, hopes to see its first UK projects getting underway during the second half of 2016 — provided its business case is proven — UK programme director Arno Schmickler has told Passive House Plus.

Energiesprong UK is a not-for-profit company founded by leading construction companies, housing associations and NGOs including the Energy Saving Trust and National Housing Federation. Its goal is to see if the Dutch Energiesprong retrofit model — founded five years ago — can work in the the UK. (Although nothing concrete has happened in Ireland yet, Energiesprong advocate Prof Ronald Rovers has twice spoken at conferences on the programme recently, and the industry is watching developments with interest.)

Energiesprong, meaning 'energy leap', was founded after the Dutch government concluded its traditional approach to supporting energy efficient upgrades — by providing grants to individual projects — wasn't reaching the number of units needed to make big cuts in carbon emissions.

So the Dutch government tasked Platform 31, a government-backed body that brought together innovative minds from different sectors to tackle big social issues, to come up with a better way. Its answer was Energiesprong — a retrofit programme that aims to deliver, in just one week, a renovation that brings each building's net energy use down to zero.

Energiesprong, which recently brokered a deal between Dutch housing associations and construction companies for the upgrade of 111,000 homes, now employs 45 people. So far 1,170 homes have been contracted, and about one quarter of these upgrades have been completed.

Energiesprong doesn't finance or carry out any work itself — its aim is to get housing associations and construction firms working together, and to stimulate the right market conditions so that large-scale retrofit becomes profitable enough to take off by itself.

The focus to date has been on social housing, because housing associations can provide the sheer volume of homes needed to drive economies of scale. But the group is now starting to look towards privately-owned homes plus schools, offices and other building types.

Energiesprong isn't prescriptive about how each upgrade is carried out — it merely sets basic standards (see 'How it measures up') for energy performance and comfort, and lets contractors decide how to meet them.

Each upgrade must be completed within one week, deliver good indoor air quality and thermal comfort, and bring the house's net energy use (i.e. its energy consumption minus renewable energy produced on site) to zero. Contractors have the freedom to figure out the fastest, best and most affordable way to meet these goals.

So far, most have tended to use prefabricated insulated panels — pre-fitted with triple-glazed windows and services — which are then installed over existing walls and roofs. Electrical solutions such as solar photovoltaics (PV) and heat pumps have also been preferred over gas or biomass.

Photos: Phillip Driessen Fotografie (construction shots) & Frank Hanswijk

Even though it's entirely up to construction companies how they meet the standard, programme manager Ron van Erck believes it's inevitable some particular technologies will dominate. "PV is going to be the major energy source of the world," he says. "The efficiency of the panels will go up, the price will continue to go down." He also sees heat pumps playing a big role as electricity grids start to rely more on renewable energy and less on fossil fuels.

In the Netherlands, the WSW social bank has put forward €6 billion in government-backed loans for the programme, enabling housing associations to pay for upgrade work. For their part, contractors are expected to provide a 30 year or 40 year guarantee of net zero energy performance.

After each upgrade, bills remain the same for tenants, but rather than pay for energy supply, they now pay a similar amount for an 'energy plan' from their housing association (rising energy prices and future inflation mean this will amount to a big saving over time).

This energy plan includes guaranteed indoor temperatures, hot water and an electricity bundle. For housing associations, it creates a long term cash flow to pay off their debt, while the upgrade safeguards the value of their property into the future.

But to work on a large scale, Energiesprong will demand a radical reinvention of the construction industry, changing its focus from one-off projects to manufacturing and product engineering. To deliver deep retrofits in such a short time, off-site prefabrication of building elements is essential.

But it's not exactly the same as manufacturing a product — like say a car —and then shipping a few million of them. Even though the Netherlands has lots of terraces, four-storey blocks and high rises, not every building will be the same. There will be different sizes and shapes, windows in different places, and different design preferences among clients.

"What you really need is a mass customisation process," van Erck told the online magazine Energy Post last year. "It shouldn't be like cars – we simply shovel them out and sell them. You need a process for measuring, making, placing and maintaining these houses." Already, construction companies in the Netherlands have been taking 3D laser scans of properties to enable them to customise prefabrication. "The bigger game here is to convert the construction sector," he says. "It's an interesting game to see develop."

Van Erck admits progress has been slower than anticipated so far in the Netherlands, but he says this is because construction companies are so new to working in this way. They're still in the innovation phase, reviewing each project after it's completed and trying to figure out how to make the next one faster, better and cheaper. "It's much better to have something good that comes a little bit later than to end up with 5,000 faulty retrofits," he says. Contractors have already driven down costs by about 40% compared to the first pilot schemes three years ago.

But what makes Energiesprong special? The pay-as-you-save philosophy — carrying out an energy retrofit and then using energy bill savings to pay for the work over time — has long been heralded as the golden ticket that will stimulate mass retrofit of cold and outdated building stock. But, as the failure of the UK's much maligned Green Deal demonstrated, it has yet to really work.

There are some important differences with Energiesprong. For a start, pay-as-you-save schemes have traditionally employed fairly modest upgrade measures (loft insulation, new boilers, draught proofing) and have assumed that — as long as the economics make sense — consumers will act rationally. Why wouldn't you spend your spare cash on cavity wall insulation instead of a new iPhone? Think of the payback!

But rather than try to entice consumers with economics, Energiesprong focuses on aesthetics and comfort. It relies on the basic fact that our spending decisions are more often motivated by desire than reason. "It's about creating a product that is desirable…it makes their house look better and increases their comfort," van Erck says.

In the Netherlands, contractors have offered Ikea kitchens and new bathrooms and other fittings to entice residents to sign up. Contractors will be responsible for the maintenance of these properties for the next 30 years, so installing new units may work out cheaper in the long run anyway. The one-week time limit for each upgrade also means minimum disruption for residents.

Energiesprong's sheer ambition also sets it apart. Getting performance guarantees and financing for modest pay-as-you-save upgrades is tough. Sure the house might have some new insulation and a better boiler — but who's to say how the occupants will use it? What if they decide to heat more rooms now that the house is more energy efficient — and thus use even more energy?

But by undertaking a deep retrofit that brings each property's net energy use down to zero (given certain conditions — see 'How it measures up'), contractors can be confident in guaranteeing the dwelling's performance. "This is much more than a pay-as-you-save mechanism…it's a deeper argument," says David Adams, technical director of energy services at construction group Willmott Dixon, another of the UK partners.

Energiesprong UK is still in its infancy. For now its main goal is to figure out how to transfer the programme from the Netherlands to Britain, and to pre-empt the challenges that may arise. But Arno Schmickler says that — if the business case for investment stacks up — the goal is to sign contracts for the first prototype projects next summer. In the longer term, the group plans to pick 5,000 housing units to kick-start a large-scale UK deep energy retrofit programme.

The biggest challenge in the UK may yet be cultural. UK contractors will have to embrace prefabrication and manufacturing in a way they haven't before — or they may even be usurped by contractors currently working on Energiesprong projects in the Netherlands. David Adams says: "I can't even name another major industry that uses a craft approach still. This clearly will not work from a craft based approach, it's got to be industrialised."

He says many of the separate elements needed to make Energiesprong work in the UK already ▶

(top to bottom) In the Netherlands, the Energiesprong project is turning old terraced housing into modern net zero energy homes through the installation of new insulated external roof and wall panels that completely transform the properties; (p79, top and bottom) most of Energiesprong's upgrades to-date have been to terraces that are owned by housing associations; (middle) prefabricated roofing with integrated roof lights being craned into position, and below this, a sample wall panel from contractor Dura Vermeer as used on Energiesprong projects, shown with cladding, insulation and built-in services

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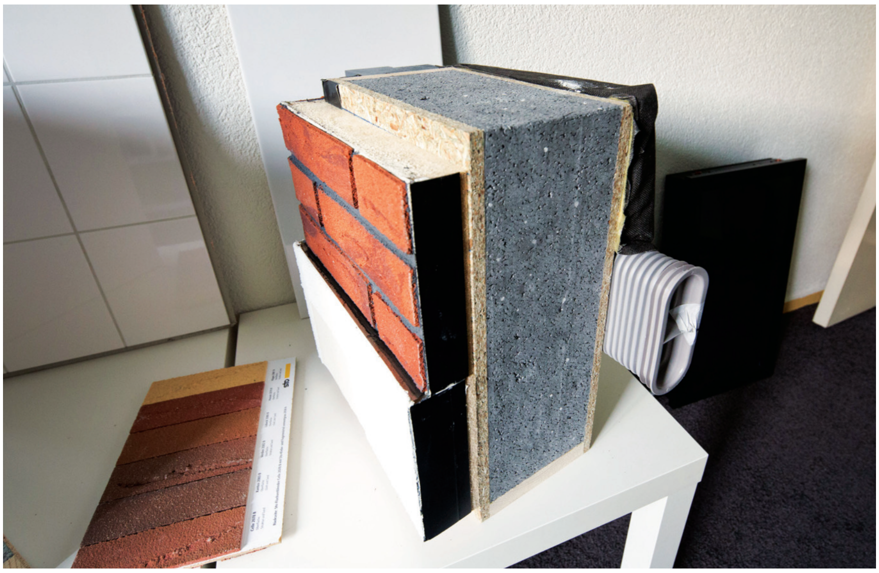


exist independently — prefabrication, passive house and fabric-first design, growing experience in deep retrofit. It's now now about combining them into one package that can be delivered ultra-quick.

"I think there is a reasonable chance of success, but we've got to prove the case — not in instances, this has got to work and be viable across thousands of homes," he says. "The next 12 months will be extremely interesting, to determine whether a really interesting concept can turn into reality."

How it measures up:

Sort of like the passive house standard, Energiesprong sets certain technical parameters that contractors must meet and then gives them freedom to decide how to go about it. In many ways Energiesprong is even less prescriptive than passive house. For example, it sets no specific airtightness standard, but assumes airtightness will be a logical part of each upgrade because it is one of the easiest and cheapest ways to reduce a building's energy consumption — and because it will be nigh on impossible to meet the technical standards with a leaky building.

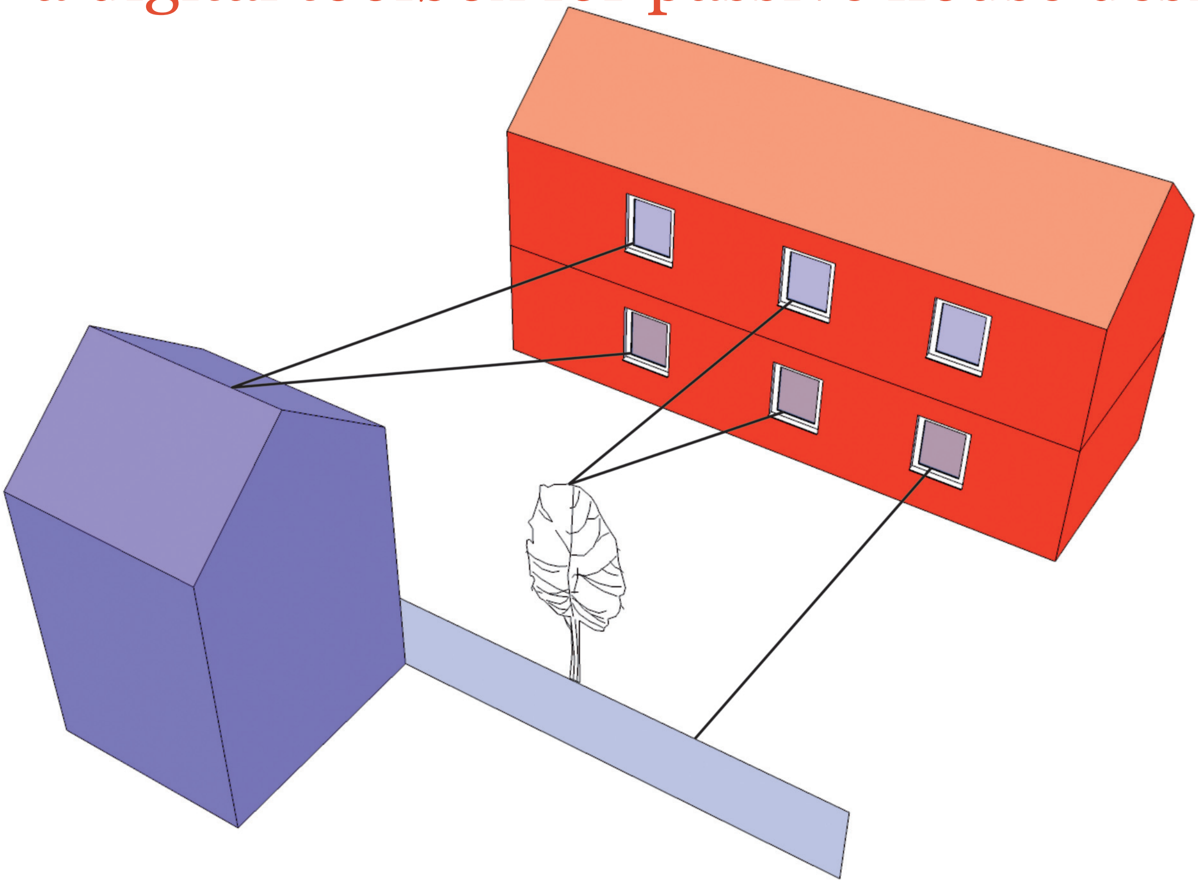
The parameters vary depending on the type of property and number of occupants, but an average specification might include:

Guaranteed net zero energy (total energy use minus renewables) consumption given the following
— Living room temperature of 21C and bedroom temperature of 18C
— 200 litres per day of hot water
— An electricity bundle for appliances of 1,500 kWh to 2,500 kWh

Comfort standards including:
— Maximum overheating of 150 hours over 26C
— Indoor CO_2 remaining below 1200 parts per million for 95% of the time
— Dutch new build ventilation standards

PHPP 9 & designPH

— a digital toolbox for passive house design



The latest versions of PHPP and designPH are intended to make passive house design both easier and more accurate than ever before — and to plan for a future powered by renewable energy. **Jan Steiger** of the Passive House Institute explains the latest features of both software packages.

Over many years, the Passive House Planning Package (PHPP) has proved extremely successful for planning new passive house buildings as well as retrofits according to the Enerphit standard. With PHPP version 9.1, released in 2015 with many new features and additions, building designers and energy consultants have an efficient digital tool at their disposal with which they can optimise their designs. In the early design phase, it is recommended that the planning tool designPH is used. This functions as a 3D data input interface for PHPP, and is available as a plugin for the design software SketchUp.

For passive house buildings designed with PHPP and designPH, planned energy demand matches exceptionally well with actual consumption, both in the case of passive house new builds and in existing buildings which have been retrofitted to the Enerphit standard. The comfort level in these buildings also meets or exceeds expectations and in most cases these construction projects can be implemented cost-effectively. Major differences between the planned energy efficiency target and actual energy consumption, known as the performance gap, do not arise with passive house and Enerphit buildings — this has been proven over the years in numerous monitored projects.

New features and additions in the PHPP 9.1

PHPP is just as well-known as the passive house standard itself. It forms an important basis for the successful implementation of passive house concepts and technologies, and is an excellent tool to plan for regulatory building programs. This year, the tried-and-tested software was revised and re-released as version 9.1. A short summary of the most important functions is presented below.

International Enerphit criteria

Building refurbishments all over the world can now be certified in accordance with the internationally applicable Enerphit criteria. In addition to the requirements for heating or cooling demand, component criteria which have been sub-divided into seven international climate zones are also now available. In this way, planners can specify the corresponding minimum standard for the relevant building components in a refurbishment project depending on the climate data of the location. In addition, the requirements for the cooling demand are determined depending on the usage-related internal loads or the climate-related cooling and dehumidification demand.

Managing step-by-step refurbishment with PHPP

Now it is possible to enter different efficiency parameters within a single PHPP file, whereas several PHPP calculations were required previously. The results of the variants are sorted into columns and calculated in parallel so that one can easily compare the effects of these parameters. Other profitability comparisons can be made in a separate worksheet.

In this way, different refurbishment steps can also be entered in a single PHPP file, and their influence on the efficiency level can be depicted. Retrofit projects which are scheduled to be completed over a long period of time can thus be documented and evaluated in a convenient way. The implementation of the variant functions of the PHPP was completed as part of the EU-funded project EuroPHit (www.europhit.eu) and tested using pilot projects.

Error messages and input options

A systematic review of the message function for missing data input or input errors was completed so that instructions or warning messages are now shown in a consistent manner in each calculation sheet, and then summarised in a newly created worksheet for this purpose. In this way, the user can quickly identify the places where data is either incorrect or incomplete and needs to be checked or reviewed.

PHPP 9 also includes many more input options for calculating the distribution losses of hot water pipes. The program takes into account significantly more piping systems, including

heat recovery systems for drain water from showers. In order to be able to evaluate the demand for hot water in more detail, it is possible to display the energy saving potential, for example, of flow-optimised fittings.

Evaluation of buildings based on renewable primary energy

Worldwide, the energy sector is undergoing rapid change, with the objective of achieving a sustainable energy supply. A planning tool for energy efficient buildings such as PHPP must be able to evaluate a building structure on this basis as well, because the calculated energy demand may largely be met by renewable energy in future.

It therefore makes sense to evaluate the energy demand of buildings that are planned today based on such a future scenario. This has already been realised in the PHPP 9 on the basis of the renewable primary energy system (primary energy renewable/PER). With immediate effect, the new system with renewable primary energy can be used to evaluate buildings as an alternative to the previously used evaluation method, which depends on the non-renewable primary energy factors (PE).

New passive house classes

The new passive house certification classes — classic, plus and premium — are based on the new PER evaluation concept. These classes allow evaluation of the building's efficiency, taking into account the interplay of energy efficiency and renewable energy generation. Furthermore, the classic passive house standard with a heating demand of 15 kWh/m²/yr and a primary energy demand of 120 kWh/m²/yr without additional renewable energy generation will continue in parallel.

According to the new evaluation system based on PER, this standard corresponds to the passive house classic class. Two other classes, passive house plus and passive house premium, allow a further increase in the efficiency of the building using the corresponding system technology and additional energy gained from renewable energy sources. Thus PHPP 9 allows tomorrow's buildings to be planned today in a future-proof way.

designPH – Data entry interface for PHPP

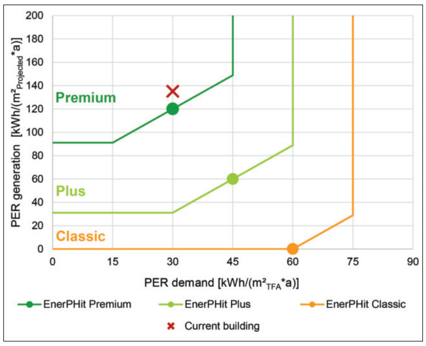
The planning tool designPH is a 3D data entry interface for PHPP, compatible with the latest version. It is installed as a plugin for the well-known 3D modelling software SketchUp and offers the user two additional tools: one for entering building data and one for energy-relevant analysis and data export into PHPP. In addition to this, the main window displays all building envelope components of the generated model with geometric and energy-relevant data. The most important features are described in detail below.

Automatic analysis of the building model

DesignPH automatically recognises all opaque and transparent components of the building model and automatically assigns these to the required group of building components such as the exterior wall, roof or window. The identified components are first allocated standard energy values. However, the specified U-values of building components or windows can be adjusted individually for each building component or selected from a list of certified passive house components in PHPP.

Energy balance calculation

An energy assessment of the model is displayed



after the analysis of the building model in designPH. The displayed heating demand is based on a simplified energy balance calculation according to the annual method in PHPP, which already takes into account the shading situation of each window. General overall values are still used for calculating some efficiency parameters such as the ventilation concept. Despite this, the building design can already be optimised in designPH with reference to energy efficiency. The building model can thus be analysed quickly and easily, particularly in the case of complex buildings, saving valuable time.

Export into PHPP

Once the design has been analysed and optimised with reference to energy efficiency, all geometric building data such as the treated floor area, envelope areas, thermal bridges, windows and shading parameters can be exported and transferred into PHPP's data sheets. In this way, the PHPP building model is quickly prepared and the user only has to adjust the parameters assumed as general values in designPH and enter the additional data for determining the heating demand. In this way, the effort required for entering project data into PHPP is considerably reduced.

Further development of designPH

Development of designPH is an ongoing process; new functions and additions are already in progress. While the current version automatically recognises and calculates the shading factors based on PHPP, the upcoming version of designPH will determine the shading parameters more accurately.

Furthermore, the user interface of designPH will be structurally revised with reference to clarity and ease of operation for more complex projects. Thus, for the purpose of identification or optimisation, individual building components will automatically be highlighted, and the display of the energy balance will be supplemented with analytical charts. Besides very detailed input of thermal bridges, it will also be possible to specify other energy-relevant components in designPH, so that the integrated energy balance calculation is improved and also so that the amount of graphically depicted data flowing into designPH is increased.

Other versions of designPH

In addition to the full version of designPH, which can only be obtained in combination with a registered version of PHPP, a demo version is now also available which can be downloaded free of charge from www.designph.org. Furthermore, students and educational institutions are now able to obtain designPH Edu for a discounted license fee. This special version is available as a bundle with the PHPP 8. DesignPH Edu is also offered as a semester license for a limited period of time. However, compared with designPH Pro, some functions are limited.

Jan Steiger studied architecture at the University of Stuttgart. As a project leader for Michel Tribus Architecture, he was involved in the design of various low energy and passive house projects. Since 2011 he has been working as a research associate for the Passive House Institute, where he leads the working group for PHPP development. He is also involved in the certification of buildings, entrance doors and construction systems.

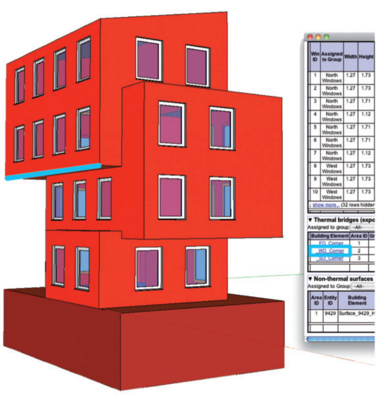
Information: New feature for experienced PHPP users (feedback welcome)! Column for 'Comparison' worksheet ▶

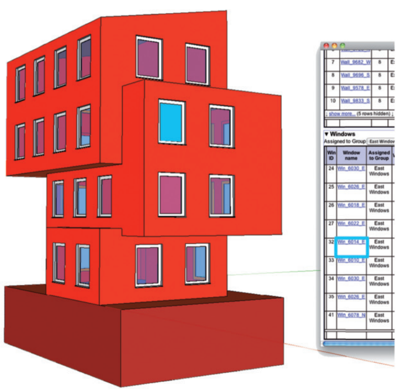
Variant calculation EnerPHit wit

Passivehouse / Climate: PHPP-Standard / TFA: 156 m² / Heating: 12,5 kWh/(m²a) / Freq. overheating: 1 % / PER: 30 kWh/(m²a)

	Select the active variant here >>>>>>>	Active: 5-EnerPHit: Windows + Ventilation	Existing Building	Insulation Basement Ceiling	Insulation Roof + PV + Solar Thermal	Insulation External Walls + Heatpump	EnerPHit: Windows + Ventilation
Results	Units	5	1	2	3	4	5
Heating demand	kWh/(m²a)	20.1	338.7	307.0	255.1	63.4	20.1
Heating load	W/m²	14.6	142.1	129.0	105.7	36.6	14.6
Cooling & dehum. demand	kWh/(m²a)						
Cooling load	W/m²						
Frequency of overheating (> 25 °C)	%	0.0	0.8	0.7	0.1	0.1	0.0
PER demand	kWh/(m²a)	39.1	1016.7	902.8	677.0	88.0	39.1
EnerPHit Classic?	yes / no	yes					yes

(main image) automatic identification of shading is an important function in designPH; (top, centre) the new passive house classes 'classic', 'plus' and 'premium' have been introduced as part of the PER (primary energy renewable) evaluation concept; (above) variants or refurbishment steps can be displayed with PHPP version 9.1; (below) once the design has been analysed and optimised with reference to energy efficiency, all geometric building data can be exported into PHPP data sheets





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